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NEW YORK, APRIL, 1889.

LAST winter was one of the mildest and most favorable to railroading known for many years. March has passed over without any repetition of the blizzard of last year, which is fortunate, because there is no indication that the railroads have profited by the lesson of the big storm. Even the Elevated roads, so far as we are aware, have not provided the little machinery necessary to prevent a repetition of the needless and annoying stoppage of trains, which caused so much of the trouble last year.

THE only bid received for the engines of the armored cruiser *Maine* is that of Messrs. N. F. Palmer, Jr. & Company, of the Quintard Iron Works, New York, whose price is $735,000. More bids wers expected by the Department, but none were received. The *Maine* is to have two vertical triple-expansion engines, with cylinders 35½ in., 57 in., and 88 in. in diameter and 36 in. stroke, each set of engines working a separate screw and each placed in a separate compartment; these engines are expected to develop 9,000 H.-P. when working under forced draft. They will be, if the specifications of the Navy Department are complied with, the finest engines of their class ever built in this country. The specifications for the engines of the battle-ship *Texas* have been prepared and distributed.

THE French Syndicate, which undertook some time ago to corner the copper market and to regulate the prices of the world's supply of this metal, seems to have finally failed, the burden of carrying the enormous amount of metal, which had accumulated on its hands having proved too great for the means at the command of the Syndicate. For some time it seemed as if it would be successful, and the price of copper in London was carried up from about $200 to $425 per ton for Chili bars. In order to maintain this price, however, it was necessary not only to make arrangements with the chief copper mines all over the world, but also to shut off the great increase of production which might be expected from the smaller and less profitable mines, which desired to seize the opportunity offered by this great increase in price. Negotiations to limit production seem to have failed, while the high price of the metal decreased consumption, and the constantly growing stock on hand proved too much for the Syndicate. Rumors affecting its strength have been frequent of late; these were finally confirmed, and on March 18 the price of copper broke in London, and Chili bars, which had been quoted a few days before at $400, were sold at $175 per ton, the lowest price on record.

The failure of the Syndicate will be disastrous to its members and backers, but manufacturers and the public generally will have but little sympathy for them, and the great copper Syndicate—if, as seems to be the case, it is really dead or fatally crippled—will be finally buried with very few mourners.

JOHN ERICSSON.

CAPTAIN JOHN ERICSSON, Engineer, late of his Swedish Majesty's Service, and since 1839 resident in the United States, died on Friday, March 8, at his house in Beach Street, in New York City. All who were acquainted with the work of this remarkable man on hearing the announcement of his death must have felt that one of the great men of the age had passed away. With the remarkable development of science and engineering and the growth of the modern means of transportation, it is hard to realize that a person whose life has just ended was a participant in that early and remarkable trial of locomotives on the Liverpool & Manchester Railroad in 1829, which may be regarded as the beginning of the railroad development of the past half century. This development has been so rapid that a single life has covered the period, from its infancy to the present time.

Captain Ericsson was born in Wermland, in Sweden, July 21, 1803, so that he was in his 86th year at the time of his death. His father was a proprietor of mines and his mother was the daughter of an iron-master. In early life John Ericsson developed a taste and genius for mechanical pursuits, and at the age of twelve he was made a cadet of mechanical engineers, and the following year a leveller on the canal. At seventeen Ericsson entered the army as ensign, and rapidly reached a lieutenancy, in consequence of his beautiful military maps, which had attracted the special attention of King Charles John (Bernadotte).

At this early period of his life he had acquired a mastery of the language, or means of representing his ideas graphically. But mechanical drawing is not only a vehicle for expressing thoughts, it is an important instrumentality to aid and systematize thought, just as algebraic symbols and formulæ assist the mathematician. Ericsson was said to be a master of graphical means of developing his ideas. He spent much of his time over a drawing-board, and took great pains to have his ideas completely and even artistically elucidated by drawings, some of which were matchless examples of the draftsman's art.

His wonderful career as an engineer was in great part due to his remarkable capacity for thus expressing his ideas in tangible form. Mechanical drawing bore the same relation to his career that language does to that of an orator or statesman. Many men think great and wise thoughts, but cannot express them; others have the gift of words, but nothing else. It is also true that few of us know how incomplete and incoherent much of our thinking

is until we put it into language. It is equally true of inventors and engineers that they never know how imperfect and undeveloped their crude ideas are until they represent them on paper, and their capacity, or rather incapacity, for working them out often puts a limit to their usefulness. It is true that many men are good draftsmen who never become great engineers or inventors, but it is perhaps equally true that without the capacity to represent his ideas definitely and clearly, a person can never reach the highest rank as an engineer or inventor.

Ericsson was a man of surpassing originality and of boundless mechanical resources and expedients, with the logical faculty of drawing deductions from the data and phenomena presented to him, and, moreover, he had the ability, which is perhaps rare with such men, of being able to express and work out graphically his deductions and conceptions into tangible form. To sum up the whole matter in other words, he was a good draftsman.

In 1826 he went to London, on leave of absence, to introduce what is called a "flame engine." No description of this invention is within reach as this account of his life is being written, but probably it was some form of what afterward was developed into the famous caloric engine. Once in England, he resigned his commission in the Swedish Army. His resignation was accepted, but he was first promoted to a captaincy. He never returned to his native country, but received many honors from his countrymen. In an account of his life which originally appeared in *Scribner's* (now the *Century*) *Magazine*, it is said:

> The records of the London Patent Office show how rapidly his inventions succeeded each other, and a list of his engineering works during the thirteen years he spent in England bears testimony to his achievements. Among these works were a pumping engine on a new principle; engines with surface condensers and no smoke stack, blowers supplying the draft, applied to the steamship *Victory* in 1828; and an engine consisting of a hollow drum which was rotated by the admission of steam, and continued to rotate for some hours after shutting off the steam, at the rate of 900 ft. per second at the circumference, or the speed of London moving around the axis of the globe. Apparatus for making salt from brine; mechanism for propelling boats on canals; a variety of motors actuated by steam or hot air; a hydrostatic weighing machine to which the Society of Arts awarded a prize; an instrument now in extensive use for taking soundings independently of the length of the lead line; a file-cutting machine, and various others, are included in this list to the extent of some fourteen patented inventions and forty machines, all novel in design.

In 1829, when the Liverpool & Manchester Railway Company offered a prize of £500 for the best locomotive-engine for their road, Ericsson entered to compete for it. The conditions were that the engine must burn its own smoke, and if it weighs six tons must draw a train, including the tender and water, weighing 20 tons, at a rate of 10 miles per hour, with a pressure of steam of 50 lbs. per square inch.

The locomotives which appeared on the ground were:

1. *The Novelty*, by Messrs. Braithwaite & Ericsson, of London, weight, 2 tons 15 cwt.

2. *The Sans Pareil*, by Mr. Hackworth, of Darlington, weight, 4 tons 8 cwt. 2 qrs.

3. *The Rocket*, by Mr. Robert Stephenson, of Newcastle-upon-Tyne, weight, 4 tons 3 cwt.

4. *The Cycloped*, by Mr. Brandreth, of Liverpool, weight, 3 tons, worked by a horse.

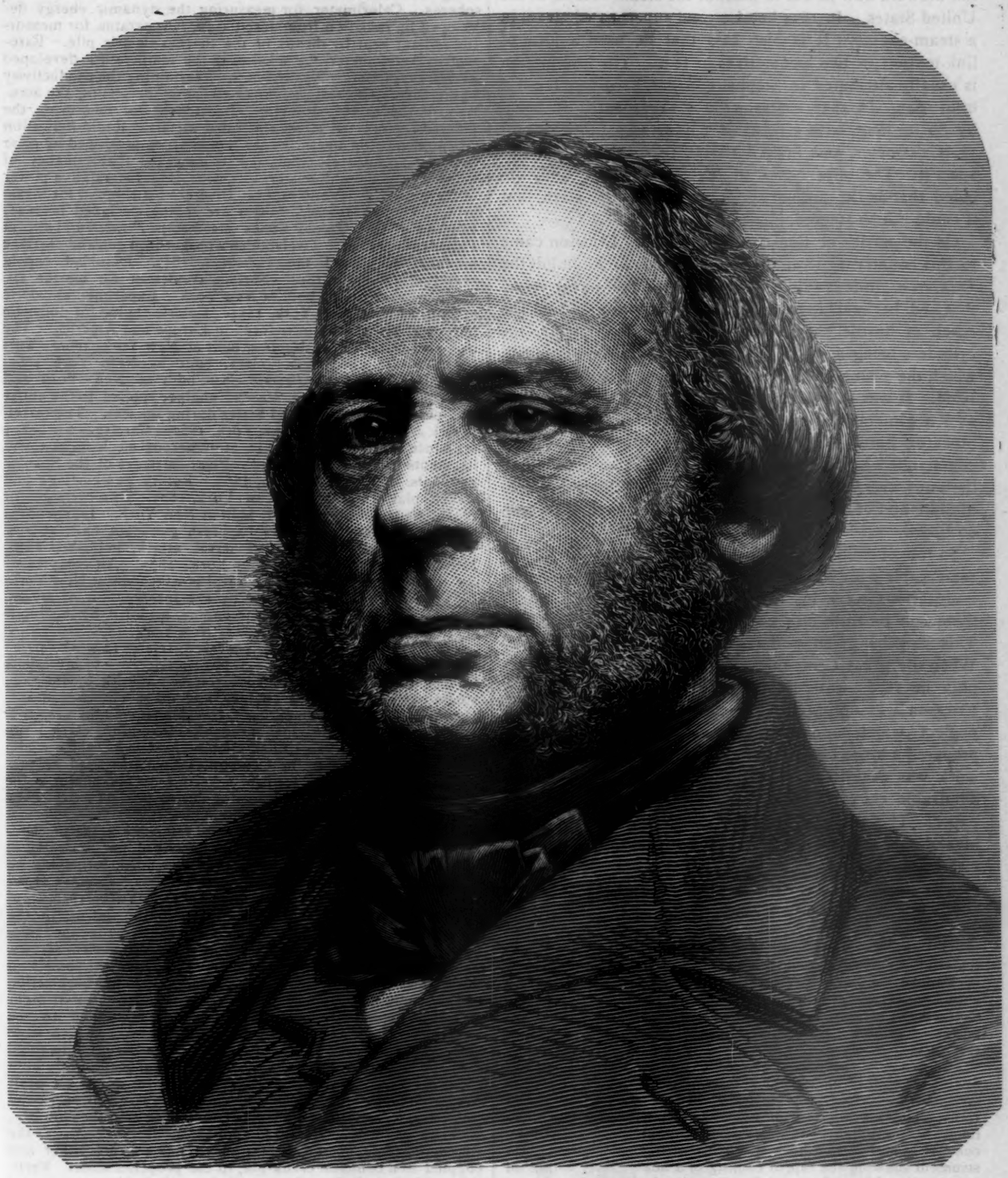
The drawing for the engraving of the *Novelty*, given on another page, was furnished some years ago to the *American Artisan* by Mr. Ericsson himself, and is, therefore, authentic. It was published in that paper and in the *Railroad Gazette* in 1875.

Accounts of this celebrated trial have been published very often and, as is well known, the prize was awarded to Stephenson's *Rocket*. The London *Times*, of October 8, 1829, said that the *Rocket*, without a train,

> Ran at the rate of 24 miles in the hour, shooting past the spectators with amazing velocity. . . . Cars weighing, with its own weight, upward of 17 tons were then attached to it, and the trial proved that the carriage (locomotive) can, drawing three times its own weight, run at the rate of more than 10 miles an hour. . . .
>
> But the speed of all the other locomotive steam-carriages in the course was far exceeded by that of Messrs. Braithwaite & Ericsson's beautiful engine from London. It was the lightest and most elegant carriage on the road yesterday, and the velocity with which it moved surprised and amazed every beholder. It shot along the line at the amazing rate of 30 miles an hour! It seemed, indeed, to fly, presenting one of the most sublime spectacles of human ingenuity and human daring the world ever beheld.
>
> But the swift *Novelty*, notwithstanding her superior speed, did not win the prize. The stipulated sum of £500 sterling was awarded to Messrs. Stephenson's *Rocket*, which engine accomplished a distance of 70 miles (by running backward and forward on the Ramhill level), at a rate of 13¼ miles an hour, with a train of cars loaded with rock, gross weight in motion, 17 tons. Much has been said *pro* and *con* respecting the fairness of the award made by the appointing judges and their determination to test a locomotive engine constructed solely for speed, and weighing only 2¾ tons, as if designed to carry goods at a slow rate. We feel no disposition to criticise the manner of conducting the trial, nor do we question the propriety of the award made by the judges appointed by the Board of Directors of the Liverpool & Manchester Railway; but we deem it fair to our professional readers and to Captain Ericsson to record the following opinion, which speaks for itself, expressed by a reflecting mechanic: "The constructor of the *Novelty* exhibited far greater engineering knowledge than the constructor of the *Rocket*. In the first place, when Stephenson presented his locomotive-engine for trial, he depended on chimney draft to support the combustion in the boiler furnaces, while Ericsson, who had theoretically considered the matter, knew that sufficient air could not be supplied by natural draft. He therefore employed a blowing apparatus, which being operated directly by an engine, regulated the combustion to suit the speed of his locomotive-engine. So well was this blowing apparatus proportioned, that, while running at the rate of 40 miles an hour, the supply of steam seemed to be ample. Fortunately for Stephenson, Timothy Hackworth, the builder of the *Sans Pareil*, discovered the efficacy of the steam-blast in time to enable the constructor of the *Rocket* to apply the same before the termination of the competitive trial. Secondly, Ericsson, fully comprehending that durability of the steam-machinery called for absence of jarring motion, placed his engine-frame on four flexible carriage springs. Nor did he overlook the fact that the power of the engines must be applied in such direction as not to interfere with the free vertical action of the springs. Consequently, he resorted to such a combination that the connecting-rods operated in a horizontal direction. And by employing bell-cranks, he dispensed with connecting-rod guides, thereby obviating the thrust and heating inseparable from their employment, unless constantly lubricated. He avoided, at the same time, the use of horizontal cylinders, so strongly objected to by most engineers of that period. Stephenson, on the other hand, employed cylinders placed at an angle of about 45°, in consequence of which fully two thirds of the power of his engines lifted and depressed the carriage at each stroke. The resulting unavoidable tilting motion was aggravated by the necessary right-angular position of the driving-cranks, causing one side of the carriage to be lifted up while the other side was being depressed. The consequent violent rocking of the *Rocket* during the competitive trial was observed by all, and admitted to be a defect which called for some effectual remedy."

In the same year that the *Novelty* was tried, Ericsson constructed a steam fire-engine which was used in putting out a fire in the Argyle Rooms, in London. Another was sent to the Liverpool docks the next year, and a third was sent to Berlin. Ten years later, in 1840, the Mechanics' Institute gave its large gold medal to Ericsson for the best system of fire-engines.

Before leaving England, Ericsson applied the principle



THE LATE CAPTAIN JOHN ERICSSON.

[Reprinted from *Harper's Weekly* for March 16, 1889. Copyright, 1889, by Harper & Brothers.]

of condensing steam and returning the fresh water to the boiler on board the *Victory*, and in the steam vessel *Corsair*, built at Liverpool in 1832, he applied the centrifugal fan blowers now in use in most of the steam vessels in the United States. In 1834 he also used superheated steam in a steam-engine. It is also said that he used a form of link-motion in two locomotives in 1830. The link-motion is usually attributed to Stephenson, but he did not use it until 1843. In 1837 Ericsson built a tug-boat 40 ft. beam by 80 ft. long, with 3 ft. draft, having two propellers of 5½ ft. diameter, and invited the British Admiralty to inspect it. The wise heads of that conservative body decided that as the propelling power was at the stern that it could not be steered.

On the advice of Commodore Stockton, Ericsson came to this country in 1839, and in 1841 began to build the *Princeton*. She is said to have been the first naval vessel that had her machinery below the water-line, out of the reach of hostile shot. Her engines were peculiar, the cylinders being made in the form of a sector of a circle, in which the pistons, which were connected to a shaft, oscillated. It was this ship that John Quincy Adams spoke of as "a gimcrack of sundry other inventions of Captain Stockton himself, was built under his directions, and is commanded by him." At a public exhibition of it one of the guns, the *Peacemaker*, burst and killed the Secretaries of State and of the Navy, and a number of other persons on board.

So full of wonderful achievements was the life of the remarkable man who is the subject of this article, and so multifarious were his achievements, that an account of them can be little else but a catalogue of what he did. This can be given perhaps best in his own words. When the great Centennial Exhibition, held in Philadelphia in 1876, was planned, through some oversight, Ericsson was not invited to exhibit his achievements, a neglect which apparently he resented. He therefore prepared a large book of 600 quarto pages in which his work was described. It was elaborately illustrated, with admirable engravings, and is printed on thick, heavy paper. The following introduction to it will give a better idea of this wonderful man's achievements than anything else could :

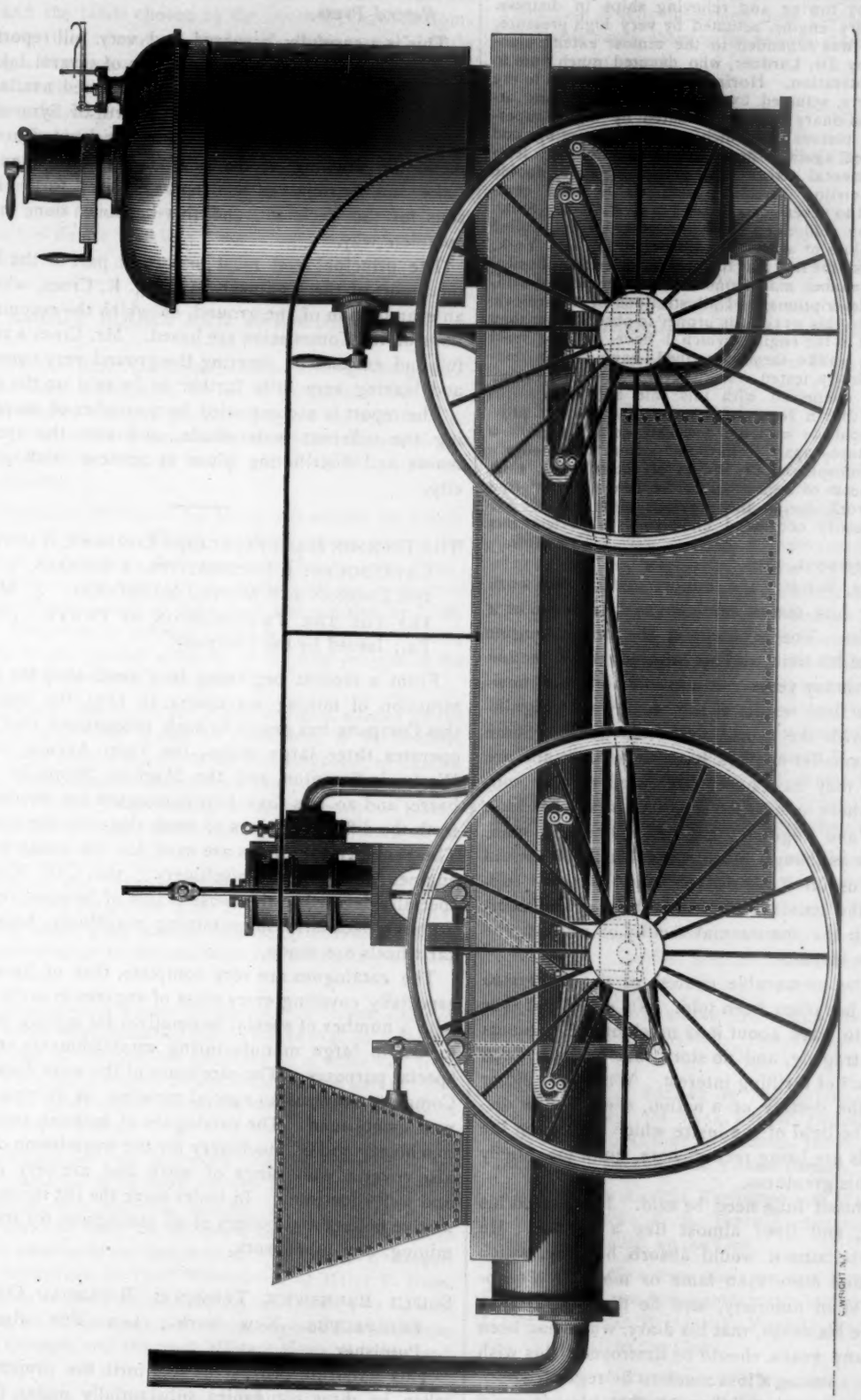
INTRODUCTION.

The Commissioners of the Centennial Exhibition having omitted to invite me to exhibit the results of my labors connected with mechanics and physics, a gap in their record of material progress exceeding one third of a century has been occasioned. I have, therefore, deemed it proper to publish a statement of my principal labors during the last third of the century, the achievements of which the promoters of the Centennial Exhibition have called upon the civilized world to recognize.

The nature of the labors referred to will be seen by the following account of philosophical instruments, engines, and other structures described and illustrated in this work—viz.: Apparatus for measuring the intensity of radiant heat at given distances. Instrument for measuring radiant heat emitted by concave spherical radiators within exhausted enclosures. Instrument showing the rate of cooling of a heated body within an exhausted cold enclosure. Instrument showing the rate of heating of a cold body within an exhausted heated enclosure. Instrument showing the rate of cooling of an incandescent sphere within an exhausted cold enclosure. Instrument for measuring the dynamic energy developed by radiant heat at different intensities. Actinometer, for measuring the temperature developed by solar radiation. Solar Calorimeter, for measuring the dynamic energy developed by solar radiation. Portable Solar Calorimeter, parallactic mechanism, for measuring the intensity of radiation from different parts of the solar disc. Instrument for measuring the radiant power of the solar envelope. Instrument for measuring the actual intensity of the sun's rays. Solar Pyrometer, for measuring the temperature of the solar surface. Apparatus for measuring the radiant intensity of flames. Instrument for measuring radiation from incandescent planes at different angles. Instrument for measuring the radiation from different zones of incandescent spheres. Calorimeter, for measuring the dynamic energy developed by radiation from fused iron. Apparatus for measuring radiant heat by means of the thermo-electric pile. Barometric Actinometer, for measuring the temperature developed by solar radiation. Apparatus for ascertaining the conductivity of mercury. Concave spherical radiator, for testing the accuracy of the solar pyrometer. Instrument for measuring the reflective power of silver and other metals. Rapid-indication Actinometer, for measuring the temperature developed by solar radiation. Apparatus for ascertaining the diathermancy of flames. Dynamic Register, for measuring the relative power of currents of water and vapor. Distance-instrument, for measuring distances at sea. Steam fire-engine, designed in 1841. Engines of the United States steamship *Princeton*, built at Philadelphia, 1842. Twelve-inch wrought-iron gun and carriage mounted on board the *Princeton*, 1843. Iron-clad cupola vessel, designed in 1854. Surface condenser for marine engines, patented 1849, built at New York Experimental caloric engine, built at New York, 1851. Caloric engine for domestic purposes, extensively introduced in Europe and America. The iron-clad turret-vessel *Monitor*, built at New York, 1861. Turret-vessels of the *Passaic* class, built at New York, 1861. Turret-vessels of the *Passaic* class, built at New York and other places, 1862. The *Monitor* engine, applied to the entire iron-clad fleet of the United States during the war. The turret-vessel *Dictator*, built at New York, 1862. Carriages for heavy ordnance, designed 1861, built at numerous mechanical establishments in the United States. Pivot-carriages of the Spanish gunboats, built at New York, 1869. Rotary gun-carriage and transit platform, built at New York, 1873. Gun-carriage for coast defense, designed 1861, built at New York. Independent twin-screw engines of the 30 Spanish gunboats, built at New York, 1869. New system of naval attack, published 1870. Movable torpedo, built at New York, 1873. Air-compressor for the transmission of mechanical power, built at New York, 1873. Solar engine, actuated by the intervention of steam, built at New York, 1870. Solar engine, actuated by the intervention of atmospheric air, built at New York, 1872.

The foregoing, it should be observed, relates to work carried out by me on American soil. It has no reference to my labors in England from 1826 to 1839 connected with locomotion, steam navigation, motive engines, and other branches of mechanical and civil engineering. Nor does it contain a *complete* enumeration of the original mechanical inventions carried into practice by me in the United States—models of which would have been presented at the Centennial Exhibition had its promoters desired me to furnish a record of my share in the progress of mechanical engineering during the last thirty-seven years of the first century of the Republic.

As our space only admits of a brief reference to the mechanical inventions adverted to and not described or illustrated in this work, the following statement is appended, furnishing an outline of the principal structures omitted—viz.: Engines of the twin-screw steamship *Clarion*, built at New York, 1840, consisting of two vertical cylinders, placed fore and aft in the vessel, actuating the cranks of the screw-shafts by inclined connecting-rods. Vertical single engines, actuating twin-screws, built at New York, 1842, applied to several freight vessels on the Delaware & Raritan Canal. Single horizontal back-action engine, built 1843, applied to the United States screw-steamer *Legaré*. Inclined screw-engines, built 1843, applied to the steamship *Massachusetts*, the steam cylinders of which were placed near the deck of the ship's sides, secured to diagonal timbers bolted to the planking. Centrifugal suction-fan, built 1843, operated by an independent engine, for producing draft in marine boilers by *drawing* the air through the furnaces and flues, and forcing the products of combustion into the chimney. Inclined engines, built 1844, applied to the bark *Edith*, the connecting-rods operating at right angles to each other and coupled to a common crank-pin, in the propeller shaft. Vertical engines, built in 1844, applied to the twin-screw vessel *Midas* (the first screw-vessel to round the Cape of Good Hope), the power being transmitted to the propeller shafts by vertical connecting-rods actuated by horizontal beams placed transversely under the deck. Vertical engines applied to numerous screw-vessels employed on the coast and inland waters of the United States, the cylinders being placed perpendicularly above the propeller-shaft, the connecting-rods acting downward—a form of engine now employed in nearly all sea-going steamers, but at that time (about 1844) severely criticised by marine engineers. Engines of the twin-screw ship *Marmora*, built 1843, consisting of vertical steam-cylinders, which, by means of beams



THE "NOVELTY" LOCOMOTIVE ENGINE.

DESIGNED BY JOHN ERICSSON AND BUILT BY JOHN BRAITHWAITE, 1829.

working under the deck and vertical connecting-rods, imparted independent motion to the propeller-shafts. Horizontal high-pressure and condensing engine of the twin-screw steam-tug *R. B. Forbes*, built 1844, provided with detached condenser and air-pump actuated by an independent engine—a vessel which, during a series of years, rendered valuable service on the coast of Massachusetts by towing and relieving ships in distress. Compound stationary engine, actuated by very high pressure, in which the steam was expanded to the utmost extent, elaborately described by Dr. Lardner, who devoted much time to its theoretical consideration. Horizontal engine applied to the screw-vessel *Primero*, actuated by a mixture of steam and atmospheric air. Stationary engines actuated by highly superheated steam, the pistons of which were single-acting and thoroughly protected against the injurious effect of high temperature. Experimental street car, propelled by a double caloric engine. Hoisting machines, actuated by cold compressed air, applied to several warehouses in New York. Small motors, actuated by cold compressed air, successfully applied to the sewing machines of a large establishment in New York, intending to establish the fact that the present injurious physical exertion of sewing-women may economically be dispensed with.

Regarding the descriptions and illustrations of the caloric engines contained in this work, it is proper to observe that they relate only to some of the engines which I have built, at least 10 different types, unlike these described, having been constructed and practically tested. Nor have I yet wholly suspended the labors connected with this safe and economical engine. The fact that it requires no water, and that its principle is not incompatible with the desirable employment of a very high temperature—apart from the important circumstance that the use of atmospheric air admits of returning at each stroke, by the process of regeneration, the heat not converted into mechanical work during the previous movement of the working piston—justify continued endeavors to perfect this remarkable motor. J. ERICSSON.

New York, September 1, 1876.

The magnitude, variety, and importance of the work that was done by him makes comment and criticism of it almost impossible. The problem of the caloric-engine engrossed much of his time, and his labors in that direction were spread over many years. It must be admitted, however, that the practical results of this work were insignificant compared with the work that was done. Some thousands of the smaller engines have been built and are now in use, but they have never been used for any considerable time where much power is required. Ericsson was an inventor and engineer and not a business man, and it seems now as though his life and his labors would have been more useful if his own capacity had been supplemented with the assistance of a clear-headed and energetic person with the commercial faculty of utilizing the discoveries of the inventor.

The story of the memorable contest of the *Merrimac* and the *Monitor* has often been told. No event that ever occurred seems to have about it so much of the elements of romance and tragedy, and no story that has ever been written was so full of thrilling interest. Whether it did or did not change the destiny of a nation, need not be discussed now, in the light of the lustre which it shed on the man whose deeds are being recited here, quite too briefly to do justice to his greatness.

Of the man himself little need be said. He devoted his life to his work, and lived almost like a recluse. He avoided society because it would absorb his time, which he seemed to value more than fame or money. He appeared, too, to shun notoriety, and he directed, only a short time before his death, that his diary, which had been kept through many years, should be destroyed; this wish was carried out, causing a loss much to be regretted.

He was a widower and childless, so that his life was a lonely one, and it may be that as the weight of years was laid slowly but surely on his shoulders, there came with it that longing which comes to many, perhaps at last to all, for rest, eternal rest.

NEW PUBLICATIONS.

REPORT OF THE COMMISSIONERS ON SOURCES OF WATER SUPPLY FOR THE CITY OF SYRACUSE, N. Y. New York; printed by the *Engineering and Building Record* Press.

This is a carefully prepared and very full report of an examination made of the water-sheds of several lakes and rivers in Central New York, which seemed available for the new supply which the rapid growth of Syracuse has made necessary. The Commission has decided to recommend the drawing of the new supply from Skaneateles Lake, and the object of this report is to set forth the reasons for this decision; and this has been done in a very complete way.

The principal and most important part of the book is the report of the Engineer, Mr. J. J. R. Croes, who made an examination of the ground, on which the recommendations of the Commission are based. Mr. Croes's report is full and exhaustive, covering the ground very completely, and leaving very little further to be said on the subject.

The report is accompanied by a number of maps showing the different water-sheds, and also the system of mains and distributing pipes at present existing in the city.

THE DICKSON MANUFACTURING COMPANY, ILLUSTRATED CATALOGUES: 1. LOCOMOTIVES. 2. BOILERS. 3. HOISTING ENGINES AND MINING MACHINERY. 4. MACHINERY FOR THE TRANSMISSION OF POWER. Scranton, Pa.; Issued by the Company.

From a modest beginning in a small shop for the construction of mining machinery, in 1855, the business of this Company has grown to such proportions that it now operates three large shops, the Penn Avenue and Cliff Works, in Scranton, and the Machine Shops, in Wilkesbarre, and no less than four catalogues are needed to set forth the different classes of work done by the Company. The Penn Avenue shops are used for the construction of engines and general machinery; the Cliff Works are specially devoted to the construction of locomotives, while in the Wilkesbarre Shops mining machinery, boilers, and car wheels are made.

The catalogues are very complete, that of locomotives especially covering every class of engines in ordinary use, with a number of special locomotives for mining work and for use in large manufacturing establishments and other special purposes. The excellence of the work done by this Company requires no special mention, as its reputation is well established. The catalogues of hoisting and mining machinery and of machinery for the trasmission of power also cover a wide range of work, and are very complete and well illustrated. In boiler work the list includes locomotive boilers and boilers of all description for stationary, mining, and other work.

SOUTH BRUNSWICK TERMINAL RAILROAD COMPANY: PROSPECTUS. New York; Leo Von Rosenberg, Publisher.

This elaborate prospectus sets forth the project undertaken by three companies substantially under the same management—the South Brunswick Terminal Company, the South Brunswick & Cordele Railroad Company, and the Brunswick Harbor and Land Company. The object of these companies is to build up a port at South Brunswick,

opposite the present town of Brunswick, Ga., and to connect this port with the railroad system of the South by a line some 150 miles in length, furnishing a new outlet to the Georgia Central and other connecting systems. The excellence of the harbor of Brunswick has often been set forth, and the lands chosen by the South Brunswick Company have the advantage that with comparatively little docking a depth of 21 ft. of water can be obtained, directly in front of the new town. The prospectus sets forth very fully the advantages of the proposed plan. It is illustrated by a number of photographs, and is gotten up in a style very much superior to most books of the kind. It has the further merit that the maps accompanying it are correct and are most admirably drawn and engraved, the credit for which is due to Mr. Von Rosenberg, the Engineer and Publisher.

ABOUT BOOKS AND PERIODICALS.

THE GAZETA ELECTRIKA, published in St. Petersburg, Russia, is the latest addition to the list of periodicals devoted to electrical science and engineering. It gives current electrical news and illustrated descriptions of new electrical apparatus. It is in the Russian language and is edited by Mr. Alphonse Schtchawinsky.

The OVERLAND MONTHLY for March has articles on American Isthmus Canals, by William L. Merry; some reasons for the decline of American Deep-sea Commerce, by John Totyl; Frontier Life in the Army, by A. Ebermayer, and a study of the extraordinary growth of the city of Los Angeles, by C. H. Shinn The article on Isthmus Canals is a brief but interesting summary of the present situation of the rival projects of the Panama and Nicaragua Companies.

The CENTURY MAGAZINE for March contains articles on the Use of Oil to Still the Waves, by Lieutenant W. H. Beehler, U.S.N., and a popular account of the Electric Motor, by Charles Barnard. Mr. Kennan continues his very interesting series by an account of the Trans-Baikal, hitherto a part of Siberia almost unknown to us, even by name, and now described for the first time.

Competition and Trusts and the Foundation Stones of the Earth are among the articles in the POPULAR SCIENCE MONTHLY for March, which gives also an interesting account of Glass-making and an essay on Natural Science in Elementary Schools, by J. M. Arms.

In the MAGAZINE OF AMERICAN HISTORY for March, attention is called to the remarkable fact that as late as 1846 an American author spoke of the possible discovery of a water-way from Hudson's Bay to the Pacific, by way of the Oregon River. This exhibition of geographical ignorance seems almost incredible to us now, but is a fact.

The JOURNAL OF THE MILITARY SERVICE INSTITUTION for March contains the prize essay, for this year, on Organization and Training of a National Reserve, by Lieutenant A. C. Sharpe; also the essay on the same subject, which received honorable mention in the competition, by Major W. C. Sanger.

Other articles are on Field Manœuvres, by Major E. Nash, and Revision of the Tactical Gaits for our Cavalry, by Colonel R. P. Hughes. There are also some interesting translations from the German, and the usual Military Notes, Reviews, and Exchanges.

Charles Francis Adams, President of the Union Pacific Company, is the author of a valuable paper, in SCRIBNER'S MAGAZINE for April, on the Prevention of Railroad Strikes. This paper was prepared by Mr. Adams in June, 1886, and submitted to several of the leading officials engaged in the management of the Union Pacific Railroad Company. It drew forth much criticism, but was finally laid aside, and its suggestions were not carried into practice.

The Building of an Ocean Greyhound is the subject of a very interesting article by William H. Rideing, in the same number. The article is fully illustrated from photographs taken in the Clyde ship-yards, showing the various stages in the building of a great ocean steamer.

BOOKS RECEIVED.

GEOLOGICAL AND TOPOGRAPHICAL MAP OF THE NEW BOSTON AND MOREA COAL LANDS IN SCHUYLKILL COUNTY, PA.: BY BENJAMIN SMITH LYMAN, ASSISTED BY AMOS P. BROWN AND J. S. ELVERSON. Philadelphia, January, 1889; issued by Benjamin S. Lyman. This is a very fine piece of local map work, made with special reference to mining engineering.

JOURNAL OF THE NEW ENGLAND WATER-WORKS ASSOCIATION; MARCH, 1889. New London, Conn.; published by the Board of Editors, Professor George H. Swain and Walter H. Richards.

REPORTS FROM THE CONSULS OF THE UNITED STATES TO THE DEPARTMENT OF STATE; NEW SERIES NO. 1, JANUARY, 1889. Washington; Government Printing Office.

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The present installment of these papers includes the Failure of the Kali Nadi Aqueduct, by Walter Hampden Thelwall; Hurst's Triangular Prismatic Formula for Earthwork, by James William Smith; Manufacture of Oil-gas on the Pintsch System and its Application to the Lighting of Railroad Carriages, by Gilbert M. Hunter; Strength of Bessemer Steel Tires, by John Oliver Arnold; Preliminary Survey in New Countries, by Theodore G. Gribble; Rapid Surveying, by Francis D. Topham; Practice in Surveying in the Australasian Colonies, by S. K. Vickery; Witham New Outfall Channel, by John Evelyn Williams; Abstract of Papers in Foreign Transactions and Periodicals.

FRICTION BRAKE DYNAMOTERS: BY WILLIAM WORBY BEAUMONT. London, England; published by the Institution of Civil Engineers.

THE FRICTION OF LOCOMOTIVE SLIDE-VALVES: BY JOHN A. F. ASPINALL. London, England; published by the Institution of Civil Engineers.

ANALES DE LA SOCIEDAD CIENTIFICA ARGENTINA; ENTREGAS 1, 2, 3, TOMO XXVI. Buenos Ayres; issued by the Society.

SIXTH ANNUAL REPORT OF THE RAILROAD COMMISSIONERS OF KANSAS, FOR THE YEAR ENDING DECEMBER 1, 1888: ALMERIN GILLETT, ALBERT R. GREENE, JAMES HUMPHREY, COMMISSIONERS. Topeka, Kan.; State Printer.

SEVENTEENTH ANNUAL REPORT OF THE WATER-WORKS, BAY CITY, MICHIGAN: E. L. DUNBAR, SUPERINTENDENT. Bay City, Mich.; issued by the City.

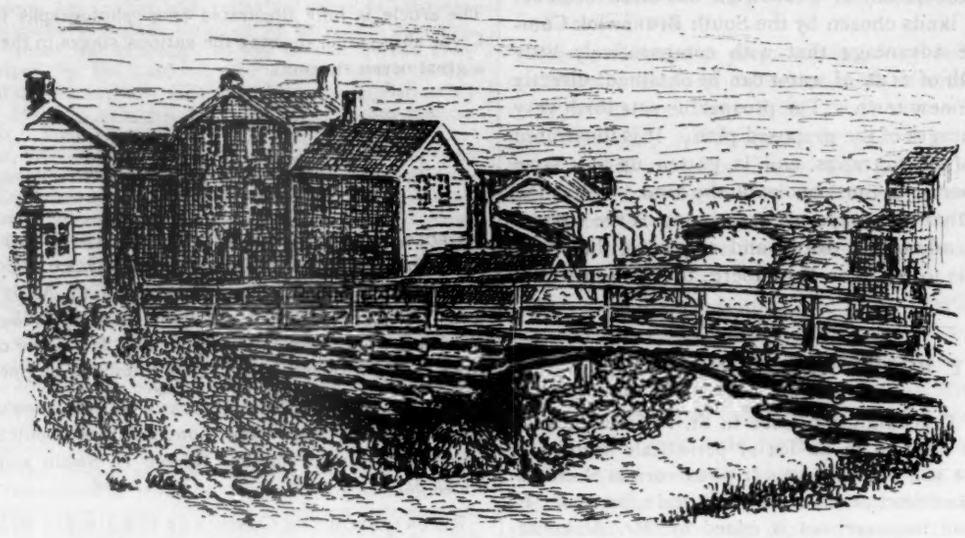
ADDRESS OF THE PRESIDENT OF THE ENGINEERS' CLUB OF CINCINNATI AT THE ANNUAL MEETING OF THE CLUB, DECEMBER 5, 1888: COLONEL WILLIAM E. MERRILL, PRESIDENT. Cincinnati, O.; issued by the Club.

HERZOGLICHE TECHNISCHE HOCHSCHULE CAROLO-WILHELMINA ZU BRAUNSCHWEIG: PROGRAMM FUR DAS STUDIENJAHR 1888-89. Brunswick, Germany; F. Vieweg & Son.

HORNIG'S DIRECT POWER-STEERING SYSTEM: JULIUS L. HORNIG, M.E. Jersey City, N. J.; E. S. Wells, Agent and Manufacturer.

CATALOGUE OF SCALES, RENSSELAER SCALE WORKS. Lansingburg, N. Y.; Arnold & Rowe, Proprietors.

THE TAPER-SLEEVE PULLEY WORKS: CATALOGUE AND PRICE-LIST. Erie, Pa.; issued by the Works.



THE EXCELSIOR IRON WORKS COMPANY: CATALOGUE. Cleveland, O.; issued by the Company.

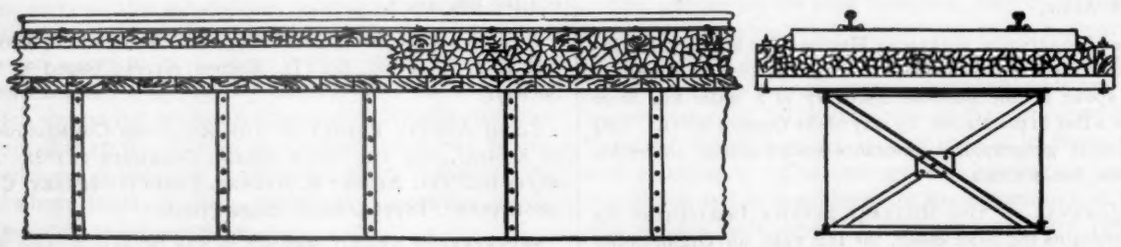
THE BRYAN MANUFACTURING COMPANY. WHEELBARROWS: CATALOGUE. Bryan, O.; issued by the Company.

CATALOGUE OF IMPROVED WOOD-WORKING MACHINERY. Williamsport, Pa.; issued by the Williamsport Machine Company.

WOODEN CANTILEVER BRIDGES.

To the Editor of the Railroad and Engineering Journal:

APROPOS of your cut and description of a bridge recently built in Sikkim (published in the February JOURNAL, page 66), I send you the accompanying sketch of a bridge at Röraas, Norway, which you will find illustrated in Du Chaillu's "Land of the Midnight Sun." He describes it as follows: "The Hitter River flows through the center of the town, the two parts being connected by picturesque wooden bridges of construction peculiar to Norway. The logs are supported by the filling at the ends, and also by the braces," as the following engraving shows.



Ethnologists used to say that there was a great deal of Tartar blood shown in the Swedes; it was recognized in their descendants about Philadelphia. Du Chaillu, in his first volume, speaks of a race of men from beyond the Black Sea, who reached Sweden by the way of Gothland, about the year 1200 A.D., whose descendants returned to Asia; perhaps they were Civil Engineers. *Quien Sabe?*

A. V.

CITY ELEVATED RAILROADS.

To the Editor of the Railroad and Engineering Journal:

I HAVE been very much interested in the various plans and schemes for rapid transit, and, while they make very good reading and sound well, yet there is apparently no immediate prospect of anything better than the present elevated roads.

Any practical plan for either underground roads or elevated stone structures through the blocks will take several years to develop and complete. In the mean time, which will cover at least the next 10 years, it seems that the best plan of elevated structure should be used and such measures for safety and comfort adopted as may be had within a reasonable limit of expense. It has been a matter of some curiosity to me as to whether any tests of the tension members of the Sixth Avenue Elevated Railroad spans have ever been made and what the effect of 10 years of almost constant vibration upon them would be.

It looks as if the Manhattan Elevated Railroad Company were taking very heavy chances with that part of its system, and while the movement of trains and service is admirable, I do not like the plans of the structures.

A plate girder is generally recognized as the best style of bridge for short spans, and such girders are used largely in Brooklyn, where the traffic is much lighter.

The plan enclosed is of a plate girder with the track carried on broken stone ballast, which in turn rests on a continuous platform of wooden planks laid crosswise; a guard is bolted along the outer end of planking to prevent the ballast dropping off into the street. The usual inner and outer tie and wheel guards may be bolted on the ties. The interposition of several inches of broken stone between the tie and the planking will do much to deaden the noise of the trains.

The joints supported on the broken stone well tamped will not pound as they do at present, which will save the rails largely. The additional weight—say 1,000 lbs., per running foot—will be dead load, and will be fully offset by the decreased effect of moving load. There is no more necessity of bolting the ties down to the bridge here than there would be on a stone viaduct. The result would be a much smoother running track, less noise, longer life of rails and ties, and, with the substitution of the plate girder, a much safer bridge.

I do not know whether this plan has ever been proposed or not. There is nothing remarkable about it and nothing but what is very easily demonstrated. F. NEARING.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

I.—OLD AND NEW GUNS.

From the bundle of wrought-iron staves, hooped together like a barrel, that figured as the first cannon, to the latest production of Krupp or Armstrong, the step is almost as great as from the original arquebuse or matchlock to the automatic wonder of Maxim. The growth of the cannon, as of the small-arm, has been gradual and attained only at the expense of patient investigation and countless experiments carried on through many centuries.

It is not proposed to enter into the details of early cannon construction, or even into a long history of the growth of heavy ordnance, prior to the introduction of the rifle. It is sufficient to say that the improvement in the construction of cannon kept pace with the development of the mechanical arts, a knowledge of the metallurgy of gun materials, and with the inventive genius of mankind.

It would hardly be safe to define a high-power gun as one that could throw a projectile with a high initial velocity. The projectile of such a gun must not only start with a high velocity, but it must be able to maintain it through a flight of thousands of yards against tremendous atmospheric resistance, and reach its object with still a large amount of stored-up energy. In other words, there must be a proper relation between the caliber of the piece and the weight of its projectile. The work a missile will do either in overcoming the resistance of the air, or of material obstacles, is always a question of $M V^2$.

The distinguishing characteristics of a typical piece of modern ordnance may be summed up in the statement that it must be a rifle, loading at the breech, have a powder chamber with a capacity for a charge of about one-half the weight of the shot, a length of bore of at least 30 calibers, and be capable of imparting to its projectile, weighing from four to five times as much as a round shot of like caliber, an initial velocity in the neighborhood of 2,000 ft. per second. Remembering that the first rifled guns used a projectile of but little more than twice the weight of a corresponding round shot, a powder charge of about one-tenth the weight of the projectile, and imparted an average initial velocity of less than 1,500 ft. per second, the magnitude of the improvement may be understood.

Leaving out of consideration for the present the question of the material to be employed in the construction of the gun, only granting that it shall possess a reasonable degree of strength, it can easily be seen that the problem before the artillerist has been how to obtain this greatly increased initial velocity without excessive pressure in the bore of the piece. Clearly this can be attained only by a change in the character of our projectile force. While the whole moment of force expended upon the projectile must be much greater than heretofore, it must be less violent in its action and longer continued.

With the powder used in heavy guns up to a comparatively recent date the grains were of medium size and of moderate density. When a charge of powder of this description is ignited, a greater part of it is converted into gas before the inertia of the projectile is overcome. If the charge be large or the projectile heavy, the pressure becomes enormous. To attempt to get a velocity of 2,000 ft. with such powder, from a rifle projectile of any kind, where all escape of gas is cut off, would be impossible with any gun metal we now possess.

The solution of the problem has been reached through the invention of slow-burning powders. This quality of slowness of burning may be obtained either by increasing the size of the individual grains or by giving them greater density, or by both. The details of the manufacture of this powder, which is said to be of German origin, are kept secret, but in addition to increased size of grain and greatly increased density, the process is supposed to involve a slight change in the proportion of the ingredients and in the methods of their manipulation. The grains are perforated through the center, and of such shape (usually a flat hexagonal prism) that they form, when placed together in a cartridge, a solid mass, the perforations in the individual grains forming continuous passages through the entire length of the cartridge, and serve to communicate the flame throughout the charge.

The combustion of a charge of dense, slow-burning powder is quite a different thing from the explosion of one of small grains and low density. During the first instants after ignition, and until the gases given off acquire considerable tension, the burning of the compact grains proceeds with relative slowness. The gas developed in these first instants is sufficient to *start* the projectile. Thereafter, although the powder gases rapidly increase in volume, the space behind the projectile increases in something like the same ratio, so that the shot leaves the bore under the impulse of a long, steady push rather than of a sharp blow.

II.—BREECH-LOADERS AND MUZZLE-LOADERS.

From what has been said it is easy to understand why our modern rifle must be a breech-loader. To obtain the results of high velocity and great momentum enormously large charges of powder are required. To accommodate a charge of this kind a chamber of about one-fifth greater diameter than the bore is necessary, and the advantages of breech-loading in this connection are obvious, while to secure from this charge its full effect the projectile must be held within its grasp until the entire mass is consumed and converted into gas, which means simply a length of bore quite double that of the old-time pieces. To attempt to load a piece of such length from the muzzle is practically out of the question.

This question of muzzle *versus* breech-loading is an old one among artillerists. The war between the two systems began with the introduction of the first rifled ordnance, and has been waged up to a very recent period.

The makers of the first cannon must have had an idea of the advantages of loading from the breech, for we find among the first guns fabricated pieces of this description. The mechanism of these pieces was exceedingly simple.

The square breech-block, which contained the powder and projectile, fitted into a vertical aperture at the rear end of the bore, and was provided with handles for lifting in and out. Probably the mechanical difficulties in the way of construction prevented its general adoption.

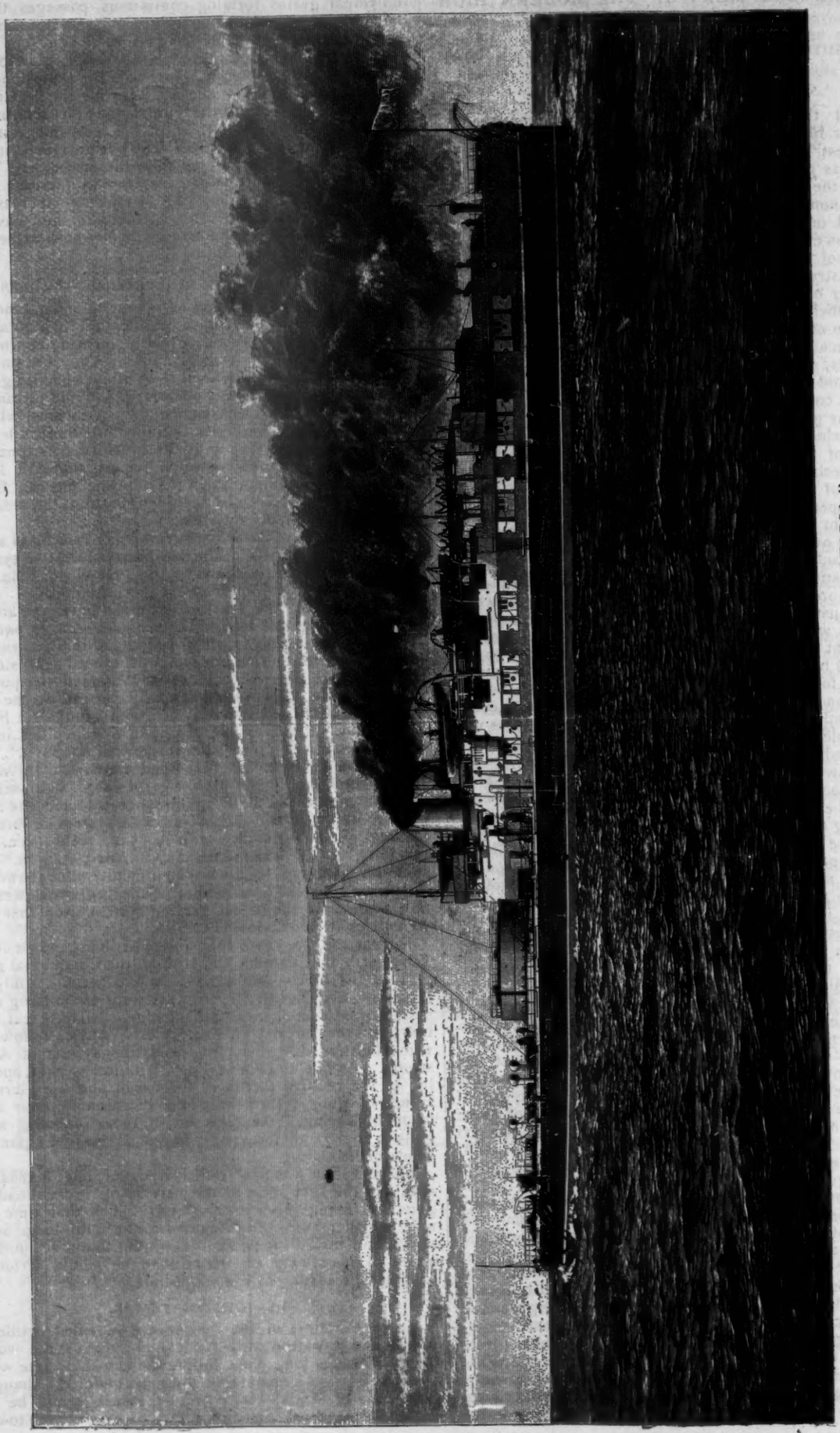
So far as we know the first rifled cannon made was a breech-loader. Armstrong, the great English gun-maker, and the pioneer in built-up ordnance, adopted the idea, and from 1855 to 1865, constructed a system of breech-loading guns, beginning with a 3-in. field-piece and reaching, at the latter date, a 7-in., 82-cwt. gun. For some reason, supposed to be the difficulty of constructing satisfactory breech mechanism in the larger calibers, he now abandoned the breech-loading system altogether and went back to muzzle-loaders.

During the 20 years that followed 1865, while with Whitworth in England, and with all the Continental gun-makers, the breech-loading system had become firmly established, the English Government went on building up a system of muzzle-loaders, until it had reached the great 100-ton gun—the Royal Gun Factory at Woolwich following, with slight modifications, the lead and system of Armstrong. As late as 1880 an English military writer, speaking of the relative merits of their own and the German system of guns, settles the whole question in their own favor by saying, "the question of breech-loading steel guns is finally and forever set at rest as far as England is concerned."

The question was not settled, however, and in 1884 we read that the first issue of the new 12-in. breech-loading guns was being made in England. Since that time the muzzle-loader has been relegated to the scrap-heap, so to speak, and no gun-maker to-day would think of building a gun on this system any more than he would seriously consider the casting of a smooth-bore.

III.—GUN MATERIAL.

Up to the time of the appearance of rifled artillery, bronze and cast-iron were the cannon metals the world over. It was a long time before the fact that these well-tried metals were unsuitable for guns under the changed conditions of strains and powder-pressure would be accepted by metallurgists and military experts. Even to-day



THE NEW ENGLISH BATTLE-SHIP "VICTORIA."

there are not wanting advocates for cast-iron as a material for rifled ordnance.

This battle of the metals has been quite as long and bitter, and the dead and disabled even more numerous than in the contest between breech-loader and muzzle-loader, as the scrap-heap and repair-shop of any ordnance proving-ground will show.

The first experiments with rifled guns were made with cast-iron pieces, both from motives of economy and from lack of knowledge of the capabilities of the metal.

England began with her cast-iron Lancaster gun, but with results so unsatisfactory that under the leadership of Armstrong a system of built-up guns, wholly of wrought-iron, was begun and has been persisted in up to a very recent period, yielding only under the pressure of costly experience some years ago to the substitution of steel for wrought-iron for the inner tubes. The guns of latest pattern and those now in course of fabrication are wholly of steel.

Prussia began the construction of rifled ordnance with cast-iron guns, first of muzzle-loaders and later of the breech loading system. But the metal was soon discovered to be unreliable, and since 1867 Krupp steel has alone been used in gun construction. From small beginnings the steel works of Krupp, at Essen, have grown to gigantic proportions and this establishment now furnishes not only all the ordnance for Germany, but supplies guns in large numbers to other powers.

Russia began the remodeling of her ordnance in much the same way as Prussia. When cast-iron was discarded, she had recourse to Krupp's breech-loading steel guns, but later founded an establishment of her own modeled upon that at Essen.

Of Italy we read much the same story of attempts to utilize old cast-iron guns, and the belief in cast-iron was held for a long time. A 100-ton cast-iron gun, hooped with steel, constructed not long since testifies to this belief. For the armament of their monster iron-clads, however, she has provided guns from the establishments of Armstrong and Krupp.

More than any other European power France has had a long and costly experience in her endeavors to use cast-iron either alone or in part in rifled-gun construction. Beginning with unbanded cast-iron pieces, the first efforts in the direction of obtaining additional strength were the employment of a single band or reinforce of steel over the breech of the gun. The addition of a second was the next improvement. This was followed by the insertion of a steel tube in the bore. Finally, resort has been had to all steel guns.

In the matter of gun-construction, Austria has followed different lines. Experience having shown that ordinary bronze or gun-metal did not possess sufficient hardness for rifled ordnance, the improvement of this metal was undertaken by General Uchatius, with the result of what is now known as "steel-bronze." There is no steel in the composition of this metal, its peculiarity consisting in the manipulation of the material. The gun of ordinary bronze is cast in an iron mold, and on a core of solid copper. This is then bored out to a size less than the finished bore by about a quarter of an inch. A series of hardened steel punches, or cones, are then forced through the bore by hydraulic pressure, each cone being slightly larger than the preceding one. By this means the interior of the bore is condensed or hardened. It was expected that guns of large caliber could be constructed upon this principle, and efforts were continued until the accidental death of the unfortunate inventor put an end to the experiments. Austria has now adopted guns of Krupp manufacture.

In the United States, owing to the superior quality and strength of cast-iron guns of the Rodman pattern, it was believed up to a very recent date by many American artillerists, and is still believed by some, that guns of American iron cast upon the Rodman principle—that is, cast hollow and cooled from the interior—could withstand even the powerful pressures rifled ordnance is called upon to bear, but the idea has never been carried beyond the exprimental stage except in connection with other metals.

In the matter of changing cast-iron smooth-bore guns into rifles, an extensive scheme of conversion was undertaken soon after the war. It was proposed to utilize our 8, 10, and 15-in. Rodmans by reboring and inserting wrought-iron tubes, reducing the calibers to 6, 8, and 12 in. respectively. Something over 100 guns of the two lower calibers have been converted, first by using a wrought-iron inner tube and later by one of steel.

A number of experimental guns of cast-iron, reinforced with steel or steel wire, are now under construction.

Built-up breech-loading guns of steel, of 6, 8, and 10-in. caliber have been constructed for the Navy, and one 8-in. Army gun of the same character has been finished and given remarkably good results in its trial.

It might be added that the early efforts to use cast-iron rifles, reinforced with a band of wrought-iron at the breech, were unfortunate. A large number of Parrott guns of this description, of 6, 8, and 10 caliber, were fabricated soon after the breaking out of the late war, and issued to both the Army and Navy. The bursting of a number of these guns in the trenches in Charleston Harbor, and later the bursting of five or six on the fleet while bombarding Fort Fisher, causing great loss of life, condemned them at once to the scrap-heap.

The latest attempts in gun-construction in this country have been in the direction of cast-steel guns. Two of these guns, of 6-in. caliber, have been cast within the past 18 months. One, of Bessemer steel, cast at Pittsburgh, was tested a few months ago at the Annapolis proving-ground, and burst at the second round. The second, of open-hearth steel, known as the Thurlow gun, was, as is well-known, subjected to trial at the same place, a short time ago, and withstood the statutory test of ten rounds satisfactorily. The question of endurance of cast-steel guns is not, however, considered as settled by practical artillerists by this trial.

In conclusion it may be said that the experience gained by 30 years of experiment goes clearly to show that steel in some form or another—cast and forged, oil-tempered, compressed, or in the form of wire, in various combinations, is to be the gun-metal of the future.

(TO BE CONTINUED.)

THE LATEST ENGLISH BATTLE-SHIP.

THE accompanying engraving, from the London *Engineer*, shows the latest battle-ship added to the English Navy. This is the *Victoria*, built by Sir W. G. Armstrong, Mitchell & Company, and launched at Elswick, April 9, 1888. The engraving is from an instantaneous photograph, showing the ship under steam.

The *Victoria* is built of steel, and the principal particulars concerning her are as follows: Tonnage displacement, 10,470; indicated horse-power, 14,244; length, 340 ft.; beam, 70 ft.; mean draft, 26 ft. 9 in.; speed, 17.3 knots, developed during speed trials in June, 1888; complement, 550 men.

The armament consists of two 110 ton (16¼-in.) breech-loading guns; one 29-ton (10-in.) gun; twelve 5-ton (6-in.) guns; twelve 6-pounder and nine 3-pounder rapid-fire guns—36 guns in all. The 110-ton guns are 43 ft. 8 in. long; their heaviest projectile weighs about 1,800 lbs. and the powder charge is 960 lbs.

The *Victoria* is rated as a first-class battle-ship. She is protected by a belt of 18-in. compound armor, extending about half the length of her hull; and rising 2 ft. 6 in. above the water. There is a covering deck, which extends to the bow and stern, where it is 3 in. thick. The turret—in which are the two 110-ton guns—is plated with 17-in. armor, and the guns will have an arc of fire from right ahead round the bow. Behind the turret is the conning tower, on top of which is a deck house. The mast of steel is really used as a derrick post for hoisting out boats, etc. A 29-ton breech-loader is carried right aft.

The engines were built by Humphreys & Tennant. The cost has been £817,841, or over $4,000,000 in all.

The *Victoria* is a much heavier ship than the *Texas*, the largest ship now under construction for our own navy. The *Texas* is 290 ft. long, 6,300 tons displacement, and carries 12-in. armor; her heaviest guns will be 12 in. Both vessels will have about the same maximum speed, but the *Texas* will have a greater cruising range.

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page 127.*)

CHAPTER XXXIX.

THE BOUHEY SPRING HAMMER.

This hammer, which is shown in figs. 123 and 124, is composed of a frame and an anvil-block cast in a single piece. The upper part of the frame carries the pulley *B* with a tightening pulley *C* and a brake *D*; at about the middle of its height it carries a crosshead *E*, provided with a spring *F* and jointed arms *G G*, and below a steel block *H*.

The shaft of the main pulley *B* carries in front the fly-wheel or crank-plate *P*, on which is fixed a crank-pin carrying the connecting rod *I*, the lower end of which is attached by the clamp *J* to the elliptic or plate spring *F*; this spring is joined at its extremities to the jointed arms *G G* and through them to the crosshead *E*. At the lower part of the crosshead is the hammer-lock *K*, which is keyed fast.

This crosshead thus receives an up-and-down motion; it moves in guides bolted to the frame. The hammerman controls the working of the hammer by means of a hand-lever *L*. By pressing on this lever the tension pulley *C* is thrown into position, the belt is tightened and the hammer works; when the handle is released, the brake acts and the movement is stopped.

While the speed of the driving-pulley *B* may be constant the speed of the hammer—that is to say, the number of blows which it strikes in a given time—may be varied at the will of the hammerman by his action on the lever *L*. This speed depends on the tension thrown upon the belt, because we obtain, on the one hand, a certain slipping of the belt which reduces the speed of the main pulley, and consequently the number and force of the blows, while with full pressure the speed of this pulley corresponds to that of the belt and the hammer works with its full force.

In order to have full command of this hammer it is best to use an intermediate shaft provided with tight and loose pulleys, so that when the hammer is not in use the driving pulley is not kept running to no purpose.

The connecting rod *I* presents one peculiarity of construction; it is composed of three parts, the middle portion being threaded at each end and joined to the others by nuts; the threads are right and left-hand so that the length of the rod can be modified at will by turning the nuts. In this way the length of the rod can be varied according to the thickness of the forging, that is to say, the approach of the hammer to the anvil-block can be regulated, the full stroke being still preserved, so that the force of the spring can be fully developed.

The force obtained with this hammer is greater than is due to the speed, the principal agent being the elastic force of the spring, which has the form of the arc of a circle. In following the action of this hammer it will be seen that when it is at the end of its stroke, and the lever begins to act upon this spring, the latter not being immediately followed by the hammer—the inertia of which offers a certain resistance to the motion—experiences a certain bending force; immediately the whole striking mass is put in motion and the hammer not only follows the spring, but jumps upward, so to speak, and produces in the spring its maximum deflection; then the crank commences its descending movement, and the spring, having reached its maximum deflection, and finding itself suddenly reversed, throws down the hammer upon the forging with a high speed, which is not only that of the lever, but also the speed of the spring itself under its reaction.

Under the influence of the shock, the hammer rises suddenly, and the more easily that the spring leaves it full liberty; it is thus free from the contact with the forging, which, with certain classes of hammers, continues for a perceptible time, and which has a cooling action upon the iron.

The total force of the blow is therefore much greater than that resulting from the weight of the crosshead, while the consumption of power is reduced in the same proportion.

When the hammer is ready to work it is not necessary that the blow should touch the anvil at its lowest point, the space between the two varying according to the force of the hammer. To regulate the distance the hammer is worked at about one-half of its normal speed, and at this speed it should touch the forging placed upon the anvil lightly; running at full speed the crosshead will thus produce a maximum effect by striking the most forcible blow. The countershaft should be placed in such a way as to leave very little space between the belt and the tightening pulley. The belt should be loose enough to slip on the pulley, without, however, giving too much play.

The crosshead should work only when the lever is thrown down, pressing the tightening pulley *C* upon the belt in such a way as to make it run either at full speed or with light blows. If this precaution is not observed, the crosshead will give counterblows, which will cause a loss of force and an irregular and jerky action.

This type of hammer possesses the following advantages: Simplicity of construction; operation by a belt which permits the use of any sort of motive power; the regulation of the blow in intensity and quickness for any given speed; the power of varying instantaneously the number and the force of the blows; the small amount of power required relatively to the effect produced; the form of the frame carrying the anvil-block in front, and thus leaving three faces of the anvil free; lastly, by its rapid and continuous blows, the forging is heated in place of being cooled while on the anvil.

The distance between the anvil and the hammer face at the end of its stroke should be about 55 mm.

The counter-blows, which should be especially avoided, will take place: 1. When the distance between the hammer and the anvil is too small. 2. When the belt is too loose and leaves too much play on the hammer-pulley; this will occur also when the distance between this pulley and the counter-shaft is too great.

These hammers should never be used for heavier work than that for which they are intended. It must be remembered that they are specially adapted to drawing out, rather than to die-work.

Their use is especially in the manufacture of arms, cutlery and for the heavier work of a coppersmith; that is, in all shops where there are many small forgings to be made.

The weight of the heaviest hammers of this type which have so far been constructed is 125 kilogrammes.

CHAPTER XL.

THE ARNS PNEUMATIC HAMMER.

This hammer, which is shown in figs. 125, 126, 127 and 128, is built by M. Beauduin, at Sedan, who holds a French patent covering the exclusive right for that country.

These hammers are built of a power varying from 6 to 100 kilogrammes. It is distinguished from other similar hammers by the simplicity of its construction; it works with a belt and can be run up to 250 blows per minute.

The alternating motion of the blow is obtained by a cast-iron piston furnished with small grooves, and having no segments. This piston moves in a cylinder solidly fixed to the frame, and is separated from the hammer by an open space, or compression chamber, which secures their joint action without interfering with their independence; this chamber forms a natural spring for the hammer. The hammer is thus drawn up by the vacuum created by the piston in its ascending stroke, while it is thrown back when the piston descends with the additional force obtained by the compression of the air.

The force of the blow is obtained by the working of a valve, which admits into the compression chamber a certain quantity of air, which is proportioned to the force of blow desired.

A brake, working with this valve, stops the hammer instantaneously at a certain height above the anvil, whatever may be the speed of the piston, and without the necessity of stopping the latter. If the valve is wide open, the brake holds the hammer in its position and the atmos-

pheric pressure no longer acts upon it; the opposite result is produced if the valve is closed, because the hammer, being drawn up by the piston, throws the brake back and acts freely again.

The piston having a large diameter can work even when the wear amounts to as much as 1 mm., because a comparatively imperfect vacuum is sufficient to raise the hammer.

The hammer itself is of cast-steel; it carries circular grooves and a longitudinal slot which prevent it from turning in the cylinder.

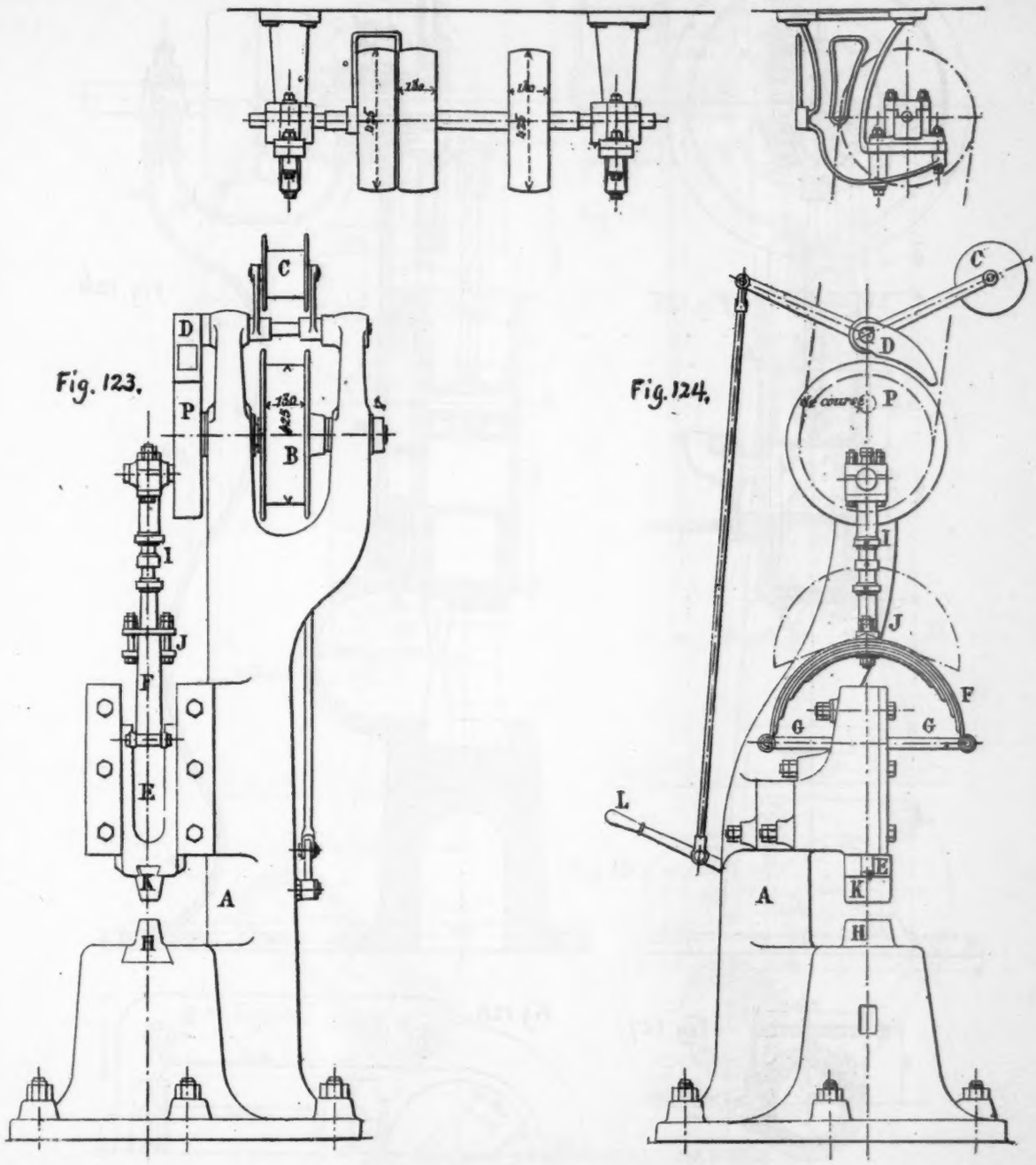
This hammer is to be recommended for its easy working, the energy of the blow which can be regulated at will, and the power of stopping its motion instantaneously without the use of a brake and the consequent wear. It is useful especially for forging and drawing out pieces of comparatively small thickness, its stroke being necessarily limited.

CHAPTER XLI.

THE CHENOT ATMOSPHERIC HAMMER.

This hammer, which is shown in figs. 129, 130, 131, and 132, is an ingenious mechanical application of the principle of the perfect elasticity of the air. It is composed of a movable cylinder *C F*, which is made of forged steel of high resistance, able to support all the shocks of working. In this cylinder two pistons *P S* and *T I* work, their working being regulated by a connecting rod *D* driven by a crank-pin *M*, which is mounted on a face-plate *P V*. This face-plate is keyed to a shaft which carries at the other end a pulley, over which runs the belt giving motion to the tool.

The rotary motion transmitted by the belt to the hammer-shaft is thus transformed directly by the face-plate and crank into a reciprocating motion of the pistons, which are joined together by the rod *T*.



THE BOUHEY SPRING HAMMER.

On the counter-shaft are placed three pulleys, the first connecting with the hammer-shaft ; a second fixed pulley carrying the driving belt from the main shaft, and a loose pulley upon which the belt can be thrown when we wish to stop the hammer.

The working of this tool is very simple. When at rest the face-plate P V is held by the brake f, but when the hammerman draws towards him the lever L, the brake is raised, and the tightening pulley T e, acting upon the belt the shaft A is then put in motion, and the stroke begins.

When the hammer touches the anvil, the lower piston P I, as it begins to rise, compresses the air in the chamber No. 2, and at a certain position of the crank-pin, the striking cylinder is set in motion on its ascending stroke by the action of the compressed air under the diaphragm D of the moving cylinder C F. The latter, once started, continues its ascending stroke, but during this time the crank-pin passes its upper dead-point and reverses the motion. At the same instant, as the diaphragm D and the upper piston P S are moving rapidly towards each other, they would strike together violently were it not for the existence of the upper cushion of air in chamber No. 1 ; the striking cylinder is thus stopped without shock and without losing its force, while the compressed air in the chamber No. 1 expands and thus restores to the cylinder all the work which was absorbed in the compression.

By the expansion of the air the striking cylinder is thus thrown down upon the anvil, producing a blow which will vary in intensity according to the speed of the shaft A.

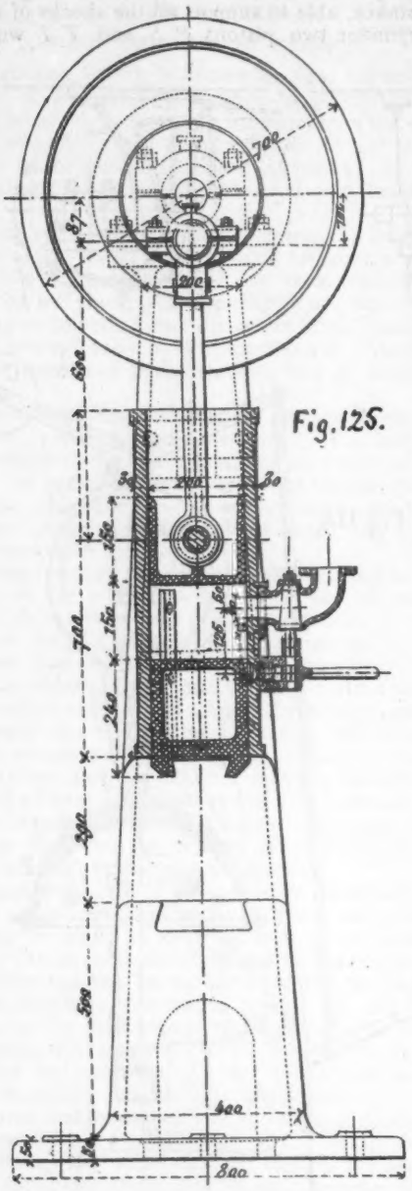


Fig. 125.

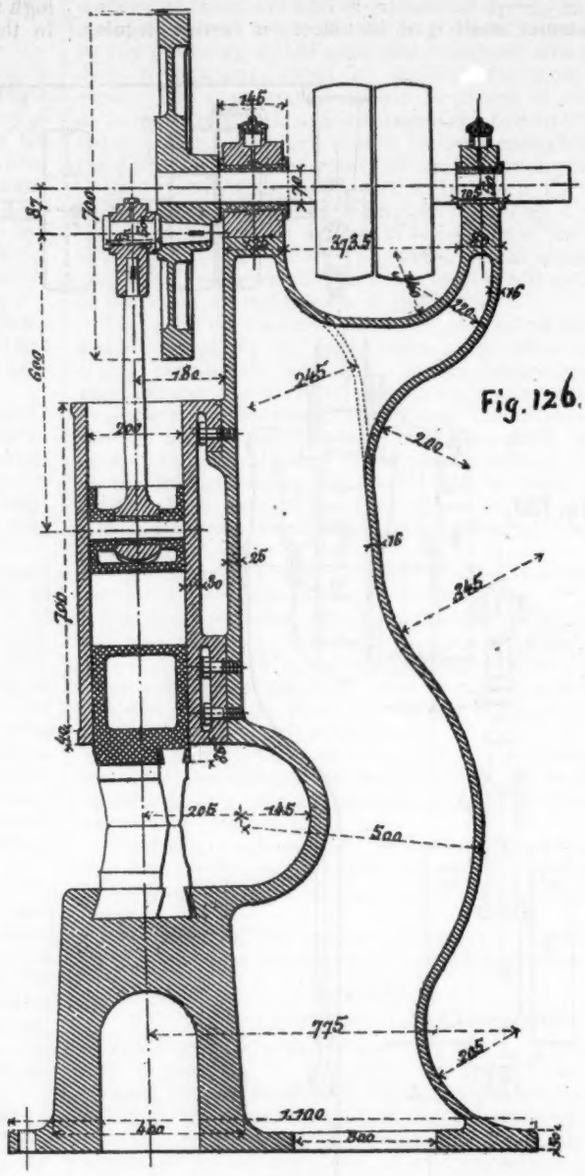


Fig. 126.

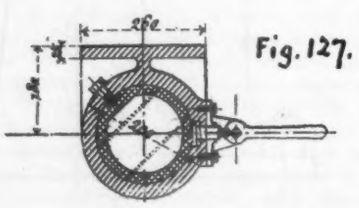


Fig. 127.

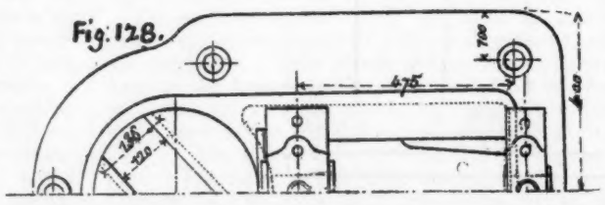


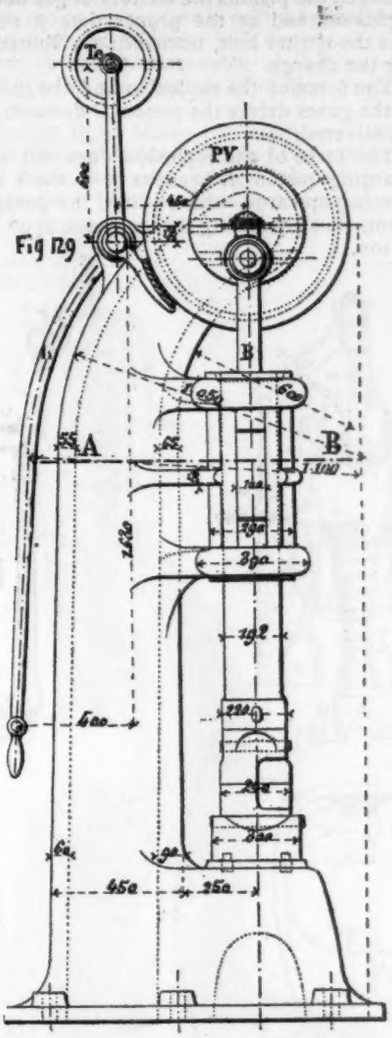
Fig. 128.

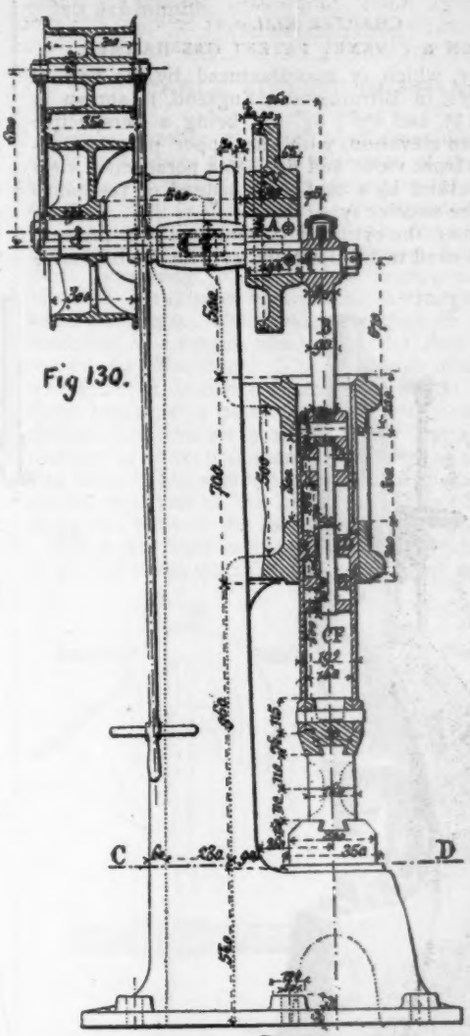
THE ARNS PNEUMATIC HAMMER.

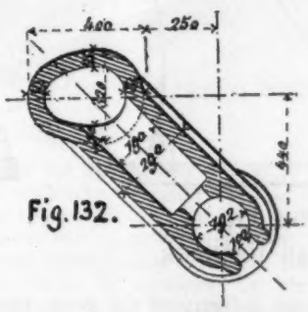
The forging is perfectly free under the hammer, since the latter rebounds immediately when the blow is given. The forging can, therefore, vary very much in form and thickness without inconvenience, since the hammer adjusts itself to any variation in thickness.

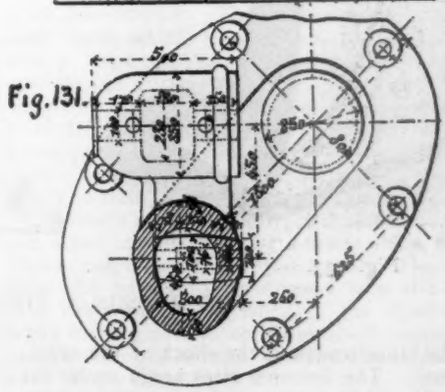
of a double-acting steam-hammer, with this difference, that the movement is given by a belt and that there may be secured in this way a considerable economy in power.

Speaking generally, these hammers when in good order and properly lubricated will utilize about 70 per cent. of









THE CHENOT ATMOSPHERIC HAMMER.

By means of the lever *L*, which works the tightening pulley, and the brake, we obtain either the instantaneous stoppage of the hammer, or any desirable degree of speed with the greatest facility.

In this system of hammer the striking cylinder is only a secondary factor in determining the intensity of the blow. The chief factor is the pressure of the air, and this pressure may run up to four or five atmospheres, this resulting from the natural play of the moving parts.

The action of this hammer is therefore similar to that

the power employed. They are especially used for forging, drawing out, and die-work.

The heaviest hammer yet made of this type is of 750 kilos. M. Chenot also makes a hammer working with air and steam mixed, the steam being admitted under a piston, the rod of which is extended and carries the striking cylinder, and can thus compress the air contained in it. In one of these hammers there have been measured by a pressure gauge pressures of 5 atmospheres in the steam cylinder and 7½ atmospheres in the air cylinder, although the

section of the latter was greater. This effect was due to the inertia of the striking mass taken up by the air spring.

This last type, although more complicated than the simple atmospheric hammer and of a somewhat delicate construction, may be extremely useful in many shops.

CHAPTER XLII.

THE ROBSON & PINKNEY PATENT GAS HAMMER.

This hammer, which is manufactured by the firm of Tangye Brothers, in Birmingham, England, is shown in figs. 133, 134, 135, and 136; fig. 133 being a perspective view; fig. 134 an elevation, with the upper part in section; fig. 135 a front view, and fig. 136 a perspective view of a hammer worked by a foot-lever instead of the hand-lever used in the smaller type.

In this hammer the cylinder *C* contains two pistons, one of which is used to fill the cylinder with the explosive mixture, while the other transmits the shock of the explosion to the hammer. The hammer rises again under the impulse given by the volute spring, and to prevent it from striking against the guides *F* a spiral spring is provided which checks the upward movement.

Examining figure 134, it will be seen that the charging piston is shown at the upper end of its stroke, a position which corresponds in working to the admission of the explosive mixture between the two pistons. This piston has two automatic valves *I I* opening from below. The piston rod *B* is guided by the stuffing-box, and is enlarged above to receive the end of the rocking-lever *K*, which is connected by the rod and crank to the hand-lever *X*. By working the latter a charging piston *A*, and the working piston *D*, are brought almost into contact, and leaving between them only a small space forming the explosion chamber. The motion of the hand-lever *X* is limited by the stop *S*. The charging piston in its upward movement expels all gases above it by means of the exhaust passage *R*, until, when its highest position is reached, this part is covered by the piston. The same movement draws in between the pistons the mixture of gas and air ready for an explosion, and at the proper time a roller on the rod *L* lifts the igniter bolt, uncovering a Bunsen flame, and firing the charge.

The force of the explosion and the continued expansion of the gases drives the piston *D* downward until the blow is delivered.

The force of the explosion does not come against the charging piston *A*, because in it there are two valves *I I* opening upwards, which allow the gases to pass through them, thus equalizing the pressure upon both sides of the piston.

Fig. 133.

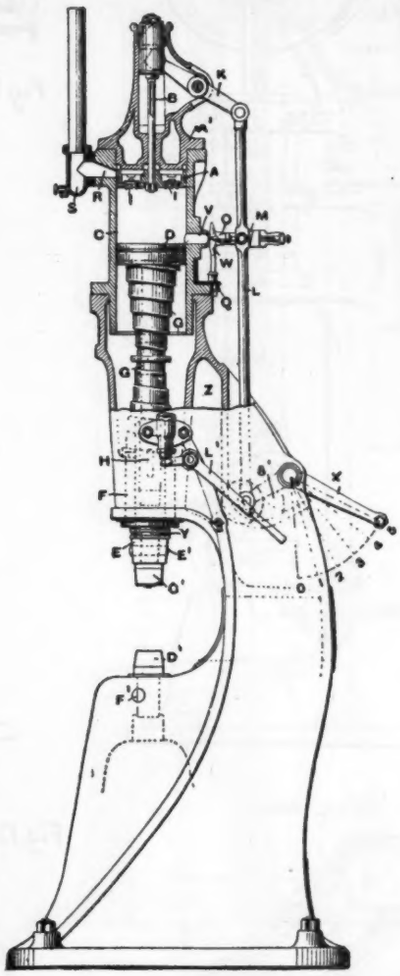


Fig. 134.

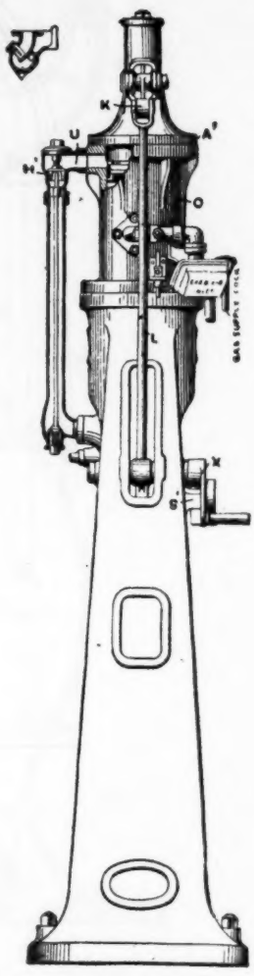


Fig. 135.

THE ROBSON & PINKNEY GAS HAMMER.

After the delivery of the blow, the charging piston is forced down by the lever *X*, and as soon as it has descended far enough to uncover the exhaust port *R*, the gases escape through the valves *I I* and the exhaust port *R*, until the pressure is reduced to that of the atmosphere. The same movement allows the igniter bolt to shut off communication with the flame.

A soon as the pressure is sufficiently reduced, the volute springs *G* raise the piston *D* and the hammer to the position shown; this upward movement being arrested by buffer springs and leather collars at *Y*. Now, the downward motion of the charging piston being continued until it is near the piston *D*, it is again raised to the position shown, and another blow delivered. This may be repeated 120 times per minute if it is desired to obtain blows of maximum force.

Now, it is evident that the charging piston, with its valves *I I*, is identically the same in its action as the plunger of an ordinary lifting pump, and that if it is brought down by the movement of the lever *X* quite close to the piston *D*, and then raised to its highest point, the space between the pistons will be filled with the explosive mixture; but if it be made to descend only part way and then raised, only as much of the explosive will be drawn in as is equal in volume to the displacement of this shorter stroke, and the force of the blow is therefore proportionally reduced.

Thus, for producing light blows the hand-lever *X* is always raised to position 5, but is depressed to position 4, 3, or 2, according to the force of the blow which it is desired to deliver, precisely like the hand-lever commonly

Fig. 136.

used in steam-hammers for controlling the slide valve; the similar movement produces precisely similar results, and the effort required to move it is no greater.

In cases where it is desired to strike very light blows, a relief valve is provided, which allows part of the pressure to escape; this valve is operated by the lever *L* in the hand machine, or in the treadle machine (fig. 136), it may be operated at will by the same motion of the foot which works the hammer. This is accomplished by fixing the plates for the foot at the ends of a crossbar which is swivelled to the lever in such a way that it may be swung around by the foot, so that in its descent it comes in contact with the relief valve lever.

The use of this gas hammer, as it has been described, requires two men, but by employing the foot-lever shown in fig. 136 the hammerman can control the operation alone. This works in very much the same way as the hand lever, but the working is, more naturally, very slow.

The result of experiments made by Mr. Dugald Clerck with an improved Richards indicator, shows that the maximum pressure actually exerted by the gas was 57 lbs. per square inch. At the commencement of the working of the hammer, which had been at rest for a considerable time, this maximum pressure was obtained for four-tenths of the stroke of the piston. It is estimated that a skilled workman using this hammer can run it up to about 120 blows per minute.

(TO BE CONTINUED.)

CABLE TOWING IN FRANCE.

FOR a number of years past experiments have been made in France, under the direction of the Government, with various plans for cable towing, or for the substitution of some form of steam-power for horses in hauling boats on the canals. These experiments have not heretofore been attended with very much success, but the latest and most promising of them has been conducted by M. Maurice Levy, who was placed in charge of the matter some time ago. The arrangement which he has made is described in a recent number of the *Portefeuille Économique des Machines*. The trial was made at Gravelle, where the St. Maurice Canal joins the St. Maur Canal at right angles, this point being chosen in order to give the system the severest possible test. The cable extends a distance of about 650 meters, covering the section between two locks. The steam-engine which operates the cable is placed near one of the locks, and the cable itself runs along one bank of the canal, returning upon the other.

The motor used in this case was a portable engine of 15 H.P., but it has usually not been called upon to furnish

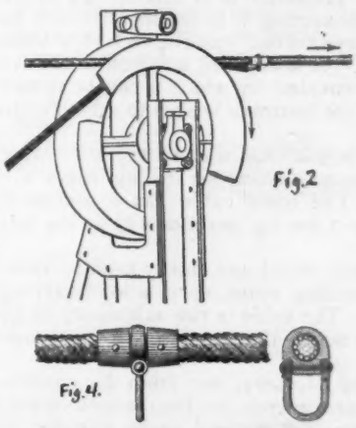


Fig. 2.

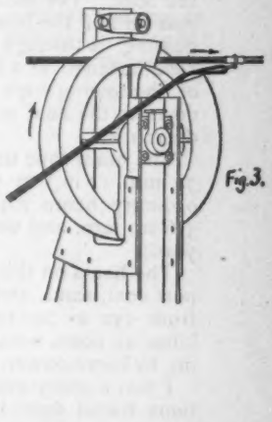


Fig. 3.

Fig. 4.

more than 10 H.P. This engine runs by a belt a driving shaft upon which is a pinion, and this pinion engages with a large spur-wheel making about 10 revolutions per minute and carrying on the shaft with it the main driving-wheel of the cable. This driving-wheel is 2 meters (6.56 ft.) in diameter, of iron lagged with wood. The cable passes over two grooved wheels which hold it in place and direct it upon the driving-pulley. The tension-pulley, which is also 2 meters in diameter, is mounted on a car, which runs upon a track 7 meters (23 ft.) in length, and which is connected by a heavy chain with a weight of 7 tons, suspended in a vertical well. The whole arrangement will be readily understood from the diagram in fig. 1, in which the center wheel of the three shown together is the driving-pulley, while the wheel mounted horizontally upon an upright is used to direct the cable to the opposite bank of the canal.

The supporting pulleys over which the cable runs are mounted on upright posts 3 meters (9.84 ft.) above the surface of the tow-path, they are 0.600 meter (2 ft.) in diameter, and the groove in them varies in width from 0.200 meter at the top to 0.120 at the bottom. This groove is slotted at the side in order to permit the passage of the tow-rop. The arrangement of the pulley and the method in which this tow-rope passes upon them with the cable, and is then disengaged, is very plainly shown by figs. 2 and 3. Fig. 4 is an enlarged view and section of the clamp and eye by which the tow-rope is fastened to the driving cable. These clamps can, of course, be put on at such intervals as may be considered desirable.

In this case special arrangements were necessary in order to overcome the right angle at the junction of the two canals. At this point it was necessary to use four large pulleys, two on each bank of the canal. There are very few cases, however, where a canal makes a bend at right angles, and for ordinary curves it is usually necessary only to employ the same pulleys for carrying the cable that are used at other points, simply giving them an inclination to the horizontal greater or less, according to the sharpness of the curve.

The method of attaching the boat to the cable is shown in fig. 5, which is an outline sketch. It will be seen that the towing-rope is attached to one of the eyes clamped on the cable; this towing rope is about 20 meters (66 ft.) in length and carries at its end an eye to which can be hooked, or otherwise fastened, the end of the rope attached to the boat. The method preferred is to attach this to the rear end of the boat, connecting it to the forward end by passing it through an eye reeved into the end of a short rope fastened to a post. A short cord attached to the eye of the towing-rope is provided by which it can be drawn down to the boat when the boatman wishes to attach or to detach it.

The main rope used in this case was a steel wire cable 31 mm. (1 in.) in diameter, while the towing ropes are ordinary hemp rope. The main cable has a section of 316 sq. mm. and weighs 2.800 kg. per meter (5.65 lbs. per yard).

The boats on this canal, which are chiefly used to transport coal, sand, and building stone, carry a load varying from 150 to 200 tons. The cable is run at a speed of 3½ kilos. an hour, which is nearly the speed of the usual towing by horse-power.

From a study made by M. Levy, and from the calculations based upon his experiments, he has arrived at certain conclusions as to the best method to be adopted in the use of this form of cable. The length of the sections will, of course, depend largely upon the position of the locks; but where there is a clear stretch the motive power stations should be placed about 20 kilom. (12½ miles) apart, and each machine would then run two cables, each

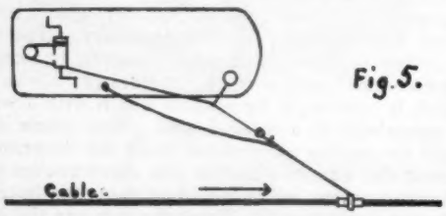


Fig. 5.

one covering a distance of 10 kilos. This length of section, M. Levy thinks, would be found most convenient usually, would not require the use of very large motors, would enable the engineers to use steam or water power, and would permit all the arrangements to be adapted to local circumstances.

The speed adopted should be the same, or a little greater, than that usually employed in horse towing, that is, about 3½ kilos. (2.18 miles) an hour. As on the French canals it generally takes about 20 minutes to pass a boat through a lock, the towing-rope attachments would be placed on the cable, running at the speed given, about 1,200 meters (4,000 ft.) apart, and there would then be about 16 boats on each cable at a time, provided the canal was fully employed, which would, of course, not always be the case. With 16 boats, all loaded, the tractive effort is estimated at 7 tons, and the engines at each station would have to be of about 150 H.P., in order to provide a sufficient reserve of power.

M. Levy, after having analyzed the irregular movement of traffic on small or branch canals, believes that the only method of providing for this consists in giving the cable a considerable tension, calculated in such a way as to keep any oscillations or irregularities of motion within narrow limits.

These experiments have been so far successful that it is proposed to make other applications of the system on the

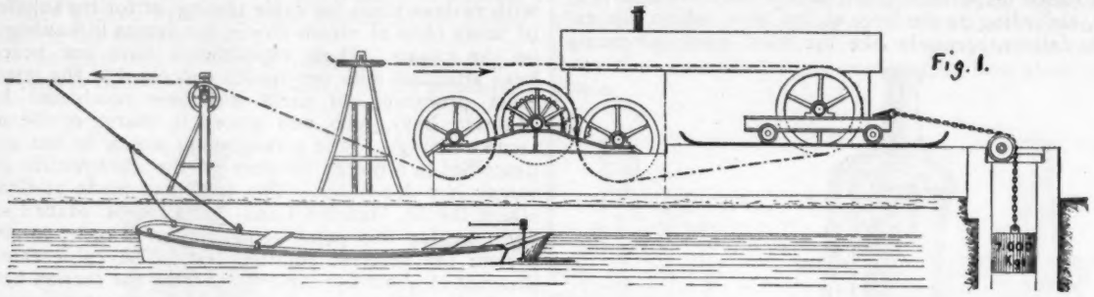


Fig. 1.

French canals, and it is probable that before long this will be done on several large sections where there is a heavy traffic. It is understood, that in order to make the cable towing profitable and to prevent any interference, the use of horses will be forbidden upon all sections where the cable is placed and all boats will be obliged to use the cable.

RAILROAD SIGNALS IN EUROPE.

(From the *Revue Generale des Chemins de Fer.*)

(*Continued from page* 122.)

X.—THE POULET SWITCH-LOCK.

To avoid the complications of the Dujour system and of other systems which we have described, M. Poulet has revived the principle of an arrangement formerly tried in England for working switches, and has applied it, at the same time modifying it so that the locking and the movement of the switch-rails is made by a single movement of the lever.

This arrangement, which is shown in fig. 56, is in use at a number of stations on the Northern Railroad of France.

By means of the lever *B* the single connecting-rod *T* works on one side the stop *P*, and on the other the bar *t* of the lock. To *t* is fixed the bent rod *k l m*, which, in its normal position, enters a slot in the connecting bar or plate *E* of the switch.

In the first part of its stroke the end *m* of the lock is drawn back and unlocks the bar; in the second part the inclined plane *k* acts upon the slot, forcing the bar from its former position and giving it the necessary movement to change the switch, while in the third part the switch is locked in its changed position.

It will be seen that this system has the advantage of locking the switch by acting on the connecting-bar directly, instead of working outside of the track. Moreover, it has an easier movement than the other systems, especially if the angles of the inclined plane of the locking bar are rounded; the motion is then transmitted with very slight resistance, and there is none of that opposition which usually forces the signalman to make a considerable exertion in moving the lever. The gain—less time taken and less fatigue to the operator—is very noticeable in a busy signal-post.

XI.—THE HENNING CAM-LOCK.

In some stations on the Swiss and the Swabian railroads M. Henning has applied a switch-lock worked by a cam, which differs from most of the systems in use in having the switch-rails independent and coupled to the locking

apparatus by distinct connecting-rods. This apparatus is shown in figs. 57, 58, and 59.

In these illustrations *A* and *C* are the two rails of a switch set, for example, for the right-hand track. The switch-rail *A* is joined by the bar a^1 *a* to the bell-crank or

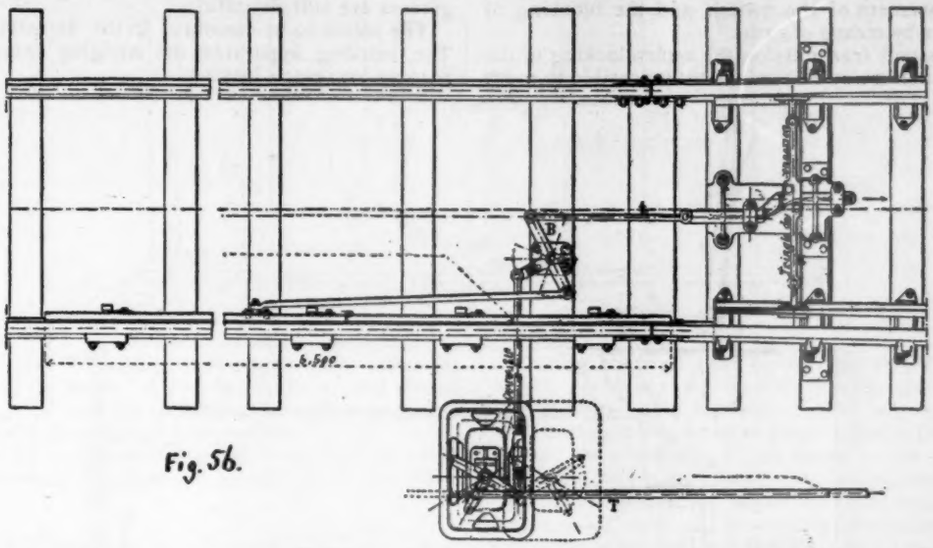


Fig. 56.

bent lever *a b c d*, and is pressed against the main rail by the lug *a* on the plate *f*; the switch-rail *C* is connected with the same lever by the rod c^1 *c*. In working the switch the lever *a b c d* takes the position shown in fig. 59; the switch-rail *A* is no longer held, but is drawn away from the rail, while the position of the switch-rail *C* is secured by the pressure of the lug f^1 against the pin *b*.

This apparatus is regulated for an average temperature, and the points *a* a^1 and *b* or *c* c^1 and *b* are then in a straight line; when the length of the connecting-rod *d* d^1 varies under the influence of a change of temperature, *a* or *c* will depart a little from their mean positions, but the lugs *f* and f^1 will always remain in contact with *a* and *b* in such a way that the position of the switch-rails is always secured.

When the switch is moved automatically—that is, by a wheel passing over it from the heel—the switch-rail *C* moves first, and the lever *a b c* turns without offering resistance. In order to prevent any risk of breaking the connecting-rod *d* d^1 the slot in which the spring-lock of the working lever catches is beveled, so that the lever can work automatically.

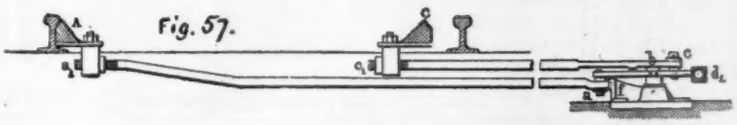


Fig. 57.

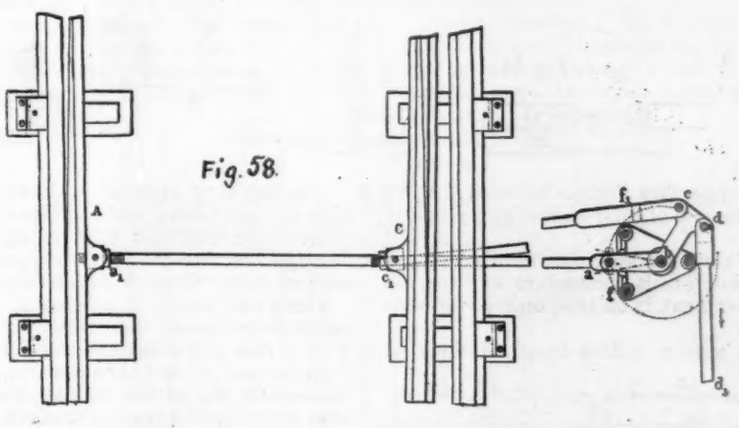


Fig. 58.

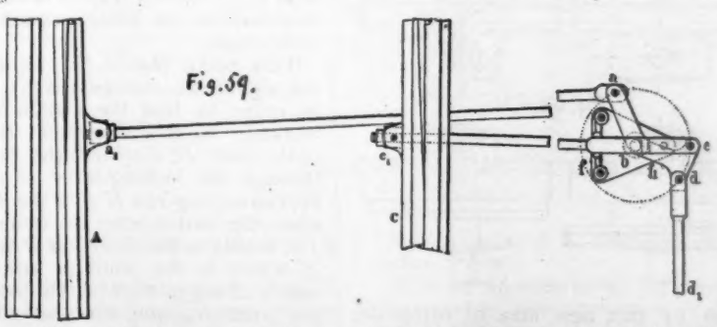


Fig. 59.

This system has its special application to switches at stations and in yards which are not preceded or covered by signals, but where it is, nevertheless, desirable to place the switches under the control of a single operator in a central post or station.

XII.—THE SERVETTAZ CAM-LOCK.

THE object of this apparatus, which has been placed in the central signal-house of the station at Savone, on the Mediterranean Railroad in Italy, is to obtain :

1. With a primary transmission, but with two distinct levers, the movement of the switch and the blocking of the switch-rails by means of cams.

2. With a second transmission the return locking of the lock-lever, in such a way that it will be impossible to move it, and to free the other apparatus interlocked with it, if the switch-rails are not at the end of their course and properly wedged.

An apparatus of this kind, working electrically both for the movement of the switch-rails themselves and for the control of the return movement, is on trial on the Northern Railroad of France.

As will be seen, this system differs from all those of which we have spoken by this new idea of using the movement of the locking apparatus to control a return movement of the lever. It is clear that in this way we escape the inconveniences resulting from the simultaneous breaking of two connections, which is always possible, though not very probable ; the signalman would be at once warned, because in that case he would find it impossible to move the switch-lever. This fertile idea has many applications, and can be carried into practice even when we replace mechanical connections by hydraulic or electric transmission. In these cases the principle of return locking continues in force, and its advantages are still more marked, since it gives means of controlling safely a movement made by the aid of forces of which some engineers are still doubtful.

The points to be examined in the Servettaz system are : The working apparatus, the wedging cams, and the apparatus for return locking.

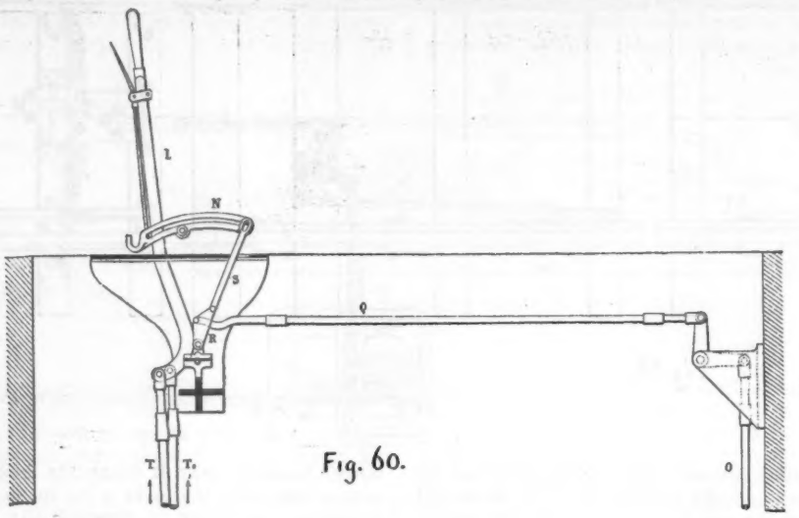


Fig. 60.

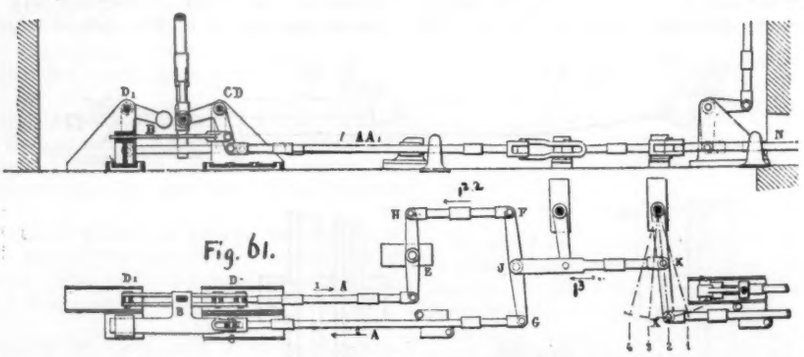


Fig. 61.

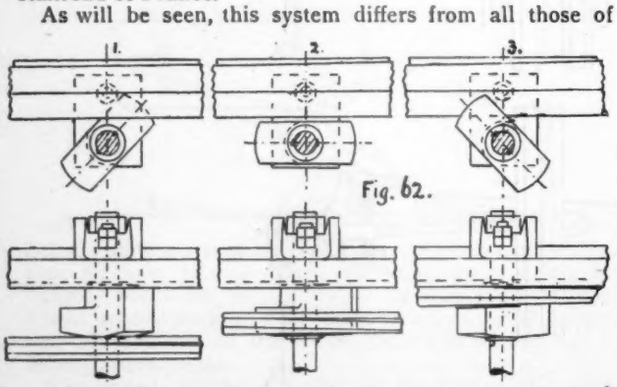


Fig. 62.

The working apparatus, shown in figs. 60 and 61, consists of two levers, one corresponding to the switch, the other to the lock, and both acting on a single connection through the use of an arrangement similar to that described in the Saxby & Farmer double-acting lock.

These two levers L command, when they are reversed in the direction of the arrow, the movement of the bars T T^1; that of the switch-lever acts through the bell-crank C on the bar A, and carries also a plate B, which serves to connect the bar of the locking lever with the plate D or with D^1, in such a way as to move the bar A, either in one direction or the other, according to the position of the switch-rails.

This being placed, the switch being normally locked, the signalman commences by reversing the locking lever in order to free the switch-rails, so that they can be worked. In this movement the bar T^1, which is united to the plate D, displaces the bar A in the direction 1, and through the locking-lever H, the connecting-rod moves the connecting-rod $H F$ in the direction 1^2; G being fixed, since the switch-lever is immovable, the connecting-rod $J K$ moves in the direction 1^3 in such a way that the point X, which is the point of attachment of the connection which changes the switch, passes from the position 1 to the position 2, the effect of which, as we will see, is to free the switch-rails.

The signalman can then reverse the switch-lever, which has the effect, through the plate C, of moving the rod A in the direction 2 ; as the locking-lever is immovable, the point F is fixed, and this movement is transmitted through the connecting-rod $J K$ to the point X, which passes from the position 2 to 3, in such a way that the switch-rails give an opposite direction to that which they

before had. At the same time the plate B causes the rod T^1, of the locking-lever to pass from the plate D^1 to the plate D.

Finally, to lock the switch-rails in their new position, the signalman returns the locking-lever to its original position; the rod T^1, acting on the square D, causes the connecting-rod to move in the direction 1, and consequently brings K into the position 4, in such a way as to lock the switch-rails in their new position.

Thus, through this combination of levers and the Saxby plates, M. Servettaz reaches the result that a movement

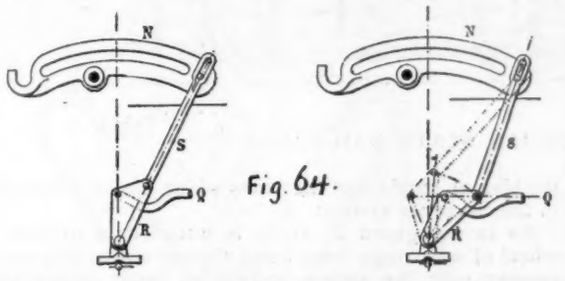


Fig. 64.

and a return movement of the locking-lever, and a reversing movement of the switch-lever are transformed into a movement in one direction of the connection between the signal cabin and the apparatus. It remains to be shown how, by the aid of this continuous transmission, the unlocking, the movement, and the relocking of the switch-rails are effected.

Instead of a lock or bolt entering the switch-rails, M. Servettaz has used a double cam, interposed on one side between one of the switch-rails and the main rail, and on the other hand forcing the other switch-rail to bear against the main rail.

Fig. 62 shows the arrangement of the cam and the position it occupies for one of the switch-rails at the close of the three stages of working which we have described.

Fig. 63 is a plan giving the position of the two cams in relation to a change of the switch, the manner in which they are moved by a single connection V, which works also a safety or guard-rail P of the ordinary type. This connection V is moved in the direction shown by the arrow, and through the bell-crank J causes the lock E to turn.

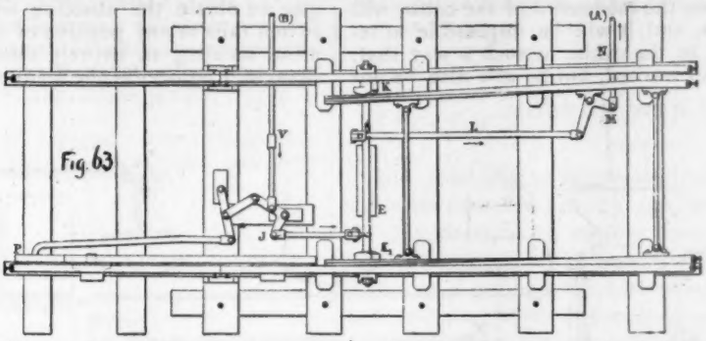


Fig. 63.

During the first part of the movement, the cam K—in the position 1, fig. 62—opposes its entire thickness to the movement of the switch-rail, but turns gradually, and, owing to its peculiar form, permits the switch-rail to move; the other cam K^1, as shown on the plan, is inclined in such a way as to force the corresponding switch-rail against the main rail, while the other cam K^1, set at an angle of 90° with K, is entirely interposed between the corresponding rail and the main rail; each switch-rail is then securely wedged fast.

Independently of this double wedging, the apparatus has this great advantage over locks with a single connection, that while the movement of the levers is subdivided into three definite stages, the movement of the switch-rails proceeds steadily by the action of the cams, the form of which has been carefully studied out in such a way as to solve this mechanical problem. The apparatus, therefore, does not present the resistance or the jerking movement which is found with locks having three separate movements.

On the bearing E, fig. 63, there is mounted a lever L which commands through the bell-crank M a special connecting-rod N, through which the return movement from the change of the switch passes through the signal cabin.

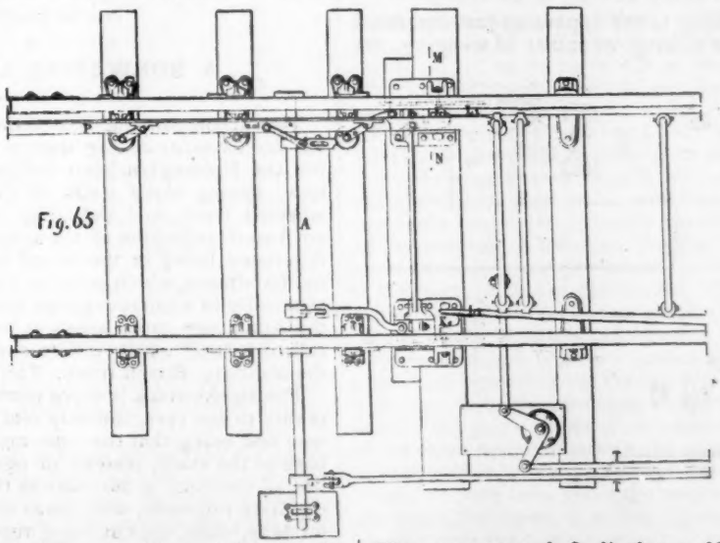


Fig. 65.

The movement of L displaces N in the direction shown by the arrow.

If, now, we refer to fig. 60, it will be seen that the displacement of this connection N is communicated to the rods O Q, the last of which works the sector R, connected to a rod S furnished with a slot, in which plays a pin fixed at the end of the link N of the lever L. Thus, account is given of the different positions, as shown in fig. 64; the sector R is laid down in such a way that the position of the point of attachment of the rod Q and of the rod S will coincide for each position of the locking-lever and of the connection N, fig. 60, and it thus results that the locking-

lever can be moved after the switch-lever has been moved, only if the position of the sector permits it; that is to say, if the connection N has been moved from its normal position; in other words, if the cams have properly wedged fast the switch-rails. In the opposite case, the connecting-rod N, which follows the movement of the cams, will not complete its course, and it will be impossible to reverse the locking-lever in the cabin, in such a way that, not only is the signalman warned, but he will also be unable to move the signals which would authorize the movement of a train over a half-open switch; this is what would happen should the connection between the cabin and the switch be broken.

It can, then, be said that this apparatus gives a control over the working of the levers which secures all desirable safety without being more expensive than the double transmission type of switch-locks.

XIII.—THE HARRISON SWITCH-LOCK.

Under a similar heading to the apparatus just described will come the system of locking, or rather of wedging, the

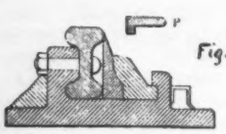


Fig. 66.

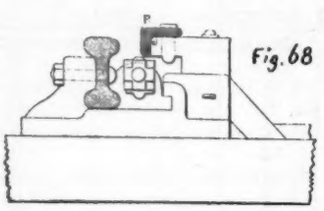


Fig. 68

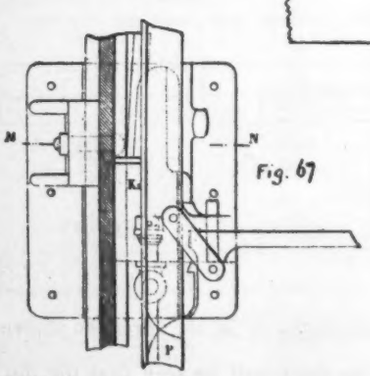


Fig. 67

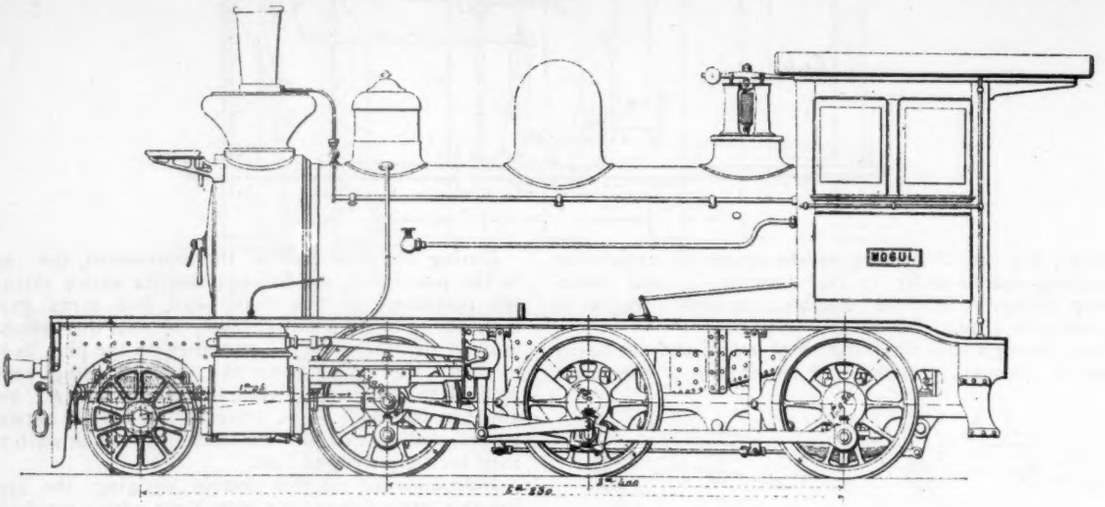
switch-rails, which has been used on the Northeastern Railroad, in England, by Mr. Harrison, Chief Engineer of that line.

As will be seen from figs. 65, 66, 67, and 68, the connection T^1, which produces this locking, is independent of the connection T which works the switch-rails $L^1 L^2$, in order to change the track; the rod T^1 rotates a horizontal shaft A, to which are attached cranks, which, according to the direction in which the shaft A moves, cause the cams $K^1 K^2$ to enter between the switch-rails and the main rail, or withdraw from them.

These cams, $K^1 K^2$, are shaped in such a way as to fit exactly between the switch-rail and the main rail, or to wedge them together according to their position. In this way we obtain the absolute wedging fast of each of the switch-rails in any position of the switch. This arrangement, securing an entirely distinct locking, has given M. Bianchi, Engineer of the Mediterranean Railroad, in Italy, the idea of employing the cams which we have described in the Servettaz system.

As to the guard P, which is intended to prevent the wheel of a carriage from being thrown out of place while passing over the switch, instead of being moved vertically, like the Saxby guard, it is moved horizontally by the action of the back-and-forth movement of the bar G, which unites the two cams. While there is a bearing against the rail the displacement of this guard is impossible, and it follows that the switch cannot be unlocked.

(TO BE CONTINUED.)



MOGUL LOCOMOTIVE, NORWEGIAN STATE RAILROADS.

A NORWEGIAN LOCOMOTIVE.

THE accompanying illustrations from the *Revue Generale des Chemins de Fer* show a narrow-gauge locomotive for the Norwegian State railroads. It is of the mogul type, having three pairs of driving-wheels and a two-wheeled truck, and the design strongly resembles that of an American engine of the same type, the only important difference being in the use of the plate-frame, instead of our bar-frame, which must be considered an improvement, especially in a narrow-gauge locomotive. The truck is of the Adamssen type, which is in use on the Swedish State railroads, and which differs somewhat in its details from the ordinary Bissell truck. The gauge is 1 meter (3.28 ft.)

The smoke-stack is more peculiar in appearance than in reality to our eyes, the only real difference from an American one being that the cone and netting are placed at the base of the stack, instead of near its top. The construction of the stack is the same as that employed on the Swedish State railroads, which was illustrated in the JOURNAL for May, 1888, the cut being reproduced herewith.

The general dimensions of this locomotive are as follows:

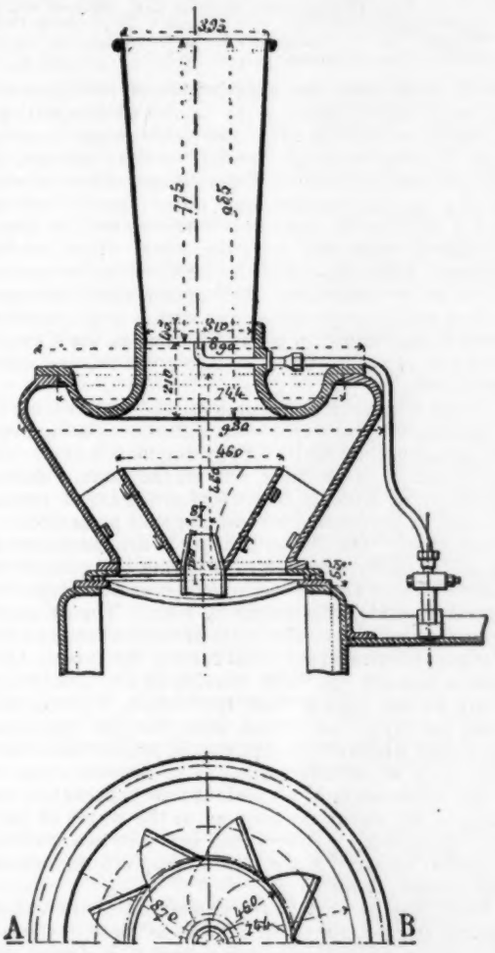
Diameter of cylinders.....	0.350 meter	(13.78 in.)
Stroke of cylinders.....	0.460 "	(18.11 in.)
Diameter of driving-wheels..	1.050 "	(41.34 in.)
Fixed wheel-base...	3.400 "	(11 ft. 1.85 in.)
Total wheel-base.....	5.230 "	(17 ft. 1.91 in.)
Grate surface.....	0.94 sq. met.	(10.11 sq. ft.)
Total heating-surface.....	56.50 " "	(607.85 sq. ft.)
Usual working pressure of steam carried.....		150 lbs.

The total weight of this locomotive in working order is

22 tons; the weight on the driving-wheels is 18½ tons; the tank has a capacity of 880 gallons, and about 2½ tons of coal can be carried.

The *Revue* makes the following general remarks on the rolling stock of the Norwegian railroads: "Whoever has traveled in the northern part of the United States will be struck in passing over the Norwegian railroads with the marked resemblance which exists between the general appearance of the system, the methods of construction, of track, and of rolling stock to the corresponding types in America.

"The narrow-gauge lines especially run through districts which, by their picturesque appearance and their



SMOKE-STACK, NORWEGIAN RAILROADS.

general configuration, recall vividly the appearance of many districts in the Northern United States. The traffic in lumber and logs, for instance, is carried on in these districts under very similar conditions and has much importance.

"It is impossible to resist the conclusion that the engineers who have laid out the Norwegian lines, and especially the narrow-gauge lines, have received their education in America, and have drawn from that country the principal elements of their technical methods. In both countries the bridges crossing the rapid and variable streams are built with the same daring originality of design and on similar plans. The locomotives almost all resemble very strongly American types of corresponding power. As to the cars, if in Norway all the details of general use in United States have not been adopted, it has been because the traffic at the time when the railroads were built was not sufficiently large to justify the use of such heavy rolling stock; but as business increases there is a constant tendency to approach more and more to the principles of construction employed in the United States.

"Among other examples of construction on these roads there is especially to be commended a postal car of very convenient design, which is carried on two trucks after the American fashion, and presents the advantage of easy running and of much greater stability than the postal cars ordinarily in use on the European railroads."

MODERN WAR-SHIPS.

THE following passages contrasting the modern war-ship with that of a century ago, and giving an outline of the classification of a modern navy, are taken from a very interesting paper read before the United States Naval Institute at Annapolis, by Lieutenant J. F. Meigs, U.S.N., and published in the *Proceedings* of the Institute.

TWO TYPICAL SHIPS.

A consideration of the changes in tactical features between the *Constitution*, built in 1797, and the *Atlanta*, built in 1883—a century apart nearly—is very striking. The table below gives the batteries of the two ships, the one given for the *Constitution* being that carried when she fought the *Guerrière*.

	Constitution.	*Atlanta.*
Guns carried.....	32 long 24s.	6 6-in. B. L. R.
	22 short 32s.	2 8-in. "
Number of guns.....	54	8
Weight of broadside... ..	684 pounds.	800 pounds.

With her long 24s, the *Constitution* could probably just about penetrate her own side—some 20 in. of oak—at 1,000 yards range; to penetrate with the short 32s, she would have to approach nearer. This ship, then, is completely protected against her own fire at ranges greater than 1,000 yards; she is impenetrable to it at greater range, and this extends, it should be noted, to the ship's life—her buoyancy and stability—and to the lives of her crew. The *Atlanta's* 6-in. guns can penetrate at 1,000 yards, about 11 in. of iron—that is, a thickness 22 times that of her side at the water line; and the 8-in. guns, at the same range, can penetrate about 14 in. of iron. And, it may be observed, the ⅝-in. steel of the *Atlanta* has just about the same resisting power as the 20-in. oak of the *Constitution*. Thus, while the defensive power of the hulls alone is the same, the later ship has a battery which has gained penetrative power in about the ratio of 25 : 1. Nor will the balance be materially altered by including in the discussion the other defensive arrangements of the *Atlanta*. Her under-water protective deck may throw off a 6-in. projectile fired at 1,000 yards range, but it hardly would an 8-in.; and, so far as the protection afforded the gun's crews by the shields goes, there is nothing gained, as these are intended only to keep out quick-fire projectiles. If we examine the danger of raking fire to the two ships, the showing of the protection of the *Atlanta* will be even worse, because, as the under-water deck does not extend to her ends, she has no protection here but what the thin plating of her side affords. It is true, then, that whereas the protection afforded to the lives of the gun's crews of the *Atlanta* and *Constitution* is of the same resisting power, the power of the main battery to penetrate is in the ratio of 25 : 1 in favor of the later ship. It follows from this, since the men who will fight the ships are much the same, that the *Atlanta's* fighting range is greater than the *Constitution's*. . . .

CLASSIFICATION OF WAR-SHIPS.

A battle ship is as large a ship as can be built, and conveniently and safely be navigated and fought. A frigate —to generalize this term—is a smaller vessel, which, in fleet operations, accompanies the liners, and sees and feels for them. Frigates also perform many minor and very necessary duties. The sloops—to generalize this term also —are sea-going craft smaller than frigates, whose functions are more purely commerce-destroying and protecting

than frigates. We operate, in naval warfare, for the control of the sea, which the enemy tries to hold by his battle-ships, while his own and foreign merchant ships supply him with every necessity. We strive, by bringing his fleets of battle-ships into pitched battles with our own, to destroy the true guardian of his sea power. Our sloops, meanwhile, operate on the merchant ships going to his ports, and evade the battle-ships, whose attention is necessarily engaged by our fleet. Our frigates stand between these two classes, and help each as they can.

Such a view of naval warfare may, perhaps, be accepted as a general one, applicable to any age or combination of weapons. Or, if the precise scheme here drawn up is erroneous, there is yet a general view of the nature here sketched out.

Such a view will, by discovering from the history of wars the object of navies, in some measure help us to decide on the principal characteristics of the various classes, as preliminary to fixing upon the installation of weapons.

The type battle-ship, already mentioned, of about 6,500 tons displacement, comes within the definition of what a battle-ship should be—as large as convenient. We have, in our country, special reasons for limiting the draft of ships to not more than 22 ft. at the outside; and it will be hard to build a ship of 6,500 tons or more with less draft. This ship should carry probably guns of about 12-in. caliber, and, to narrow the matter down still more, two such guns might be mounted in a turret armored with 10 in. or 12 in. of steel; and the ship might carry in addition a battery of numerous 6-in. or 5-in. guns. These should be protected by stout steel shields, of such form as to give efficient protection.

The frigate should be of about 3,500 tons displacement. The ratio between the offense and the defense in these ships should approach that existing in battle-ships. This, it may be observed, is the direct contrary of the rule of practice now adopted; for no vessels of 3,500 tons are *armored*, but are *protected*—to use the phraseology now current—and in all protected ships the offense exceeds the defense far more than in armored ships. This will require frigates—or "second or third-class protected cruisers," as they are frequently called—to be better protected, and their guns to be lighter than now. The protection to the ship herself may be in the way either of a vertical armor-belt at the water-line, or by a protective deck. The guns and gun's-crews must also be protected better than they are now, as a rule. Armor 3 in. or 4 in. thick, and so disposed as to receive blows in a glancing direction, will give protection in many cases, and should be applied athwartships, and wherever necessary on the beam.

To decide upon the offensive and defensive arrangements of a frigate, if we admit a certain ratio of power between these, it is sufficient to decide upon the guns. These should probably be of about 5-in. caliber. Guns of 5-in. caliber, though usually not dangerous to the supposed battle-ship, would yet be so if she were disabled, and if the range were very short. If one or two heavy guns in addition to the battery of 5-in. guns were desired, they should be of full 9-in. bore. My view of large guns in small ships is, however, that they will be useful only in the irregular operations of war—bombardments, the capture of disabled ships of higher rates, etc. The rule will be in the future, as in the past, that vessels will contend with their likes; and of two frigates of 3,500 tons, one carrying two 9-in. guns, and the other an equal weight in twelve 5-in. guns, the latter has certainly the best chance of winning.

The sloop type-ships should be of about 1,500 tons displacement, and their batteries would be mostly of guns of about 4-in. caliber. Here, too, my view is that present types lack in defensive arrangements. The ⅜-in. protective deck of our gunboats and of the class of the English *Archer* will hardly throw off a 3-pounder rapid-fire gun when the range is short; and yet the two classes named are the best protected in the world for their tonnage.

The scheme presented of a convenient classification of war-ships is, of course, open to criticism in all respects; and, perhaps, the best result which can flow from its presentation is the realization of the necessity for a comprehensive plan. The growth of a type of war-ship is an extraordinary and most complex study, and all that any individual can do to fix or control it is infinitesimal in amount.

The scheme presented lays down, from a study of naval wars and of present needs, the three classes of battle-ships, frigates, and sloops. The first we make as big as is safe and convenient; their office is to fight similar ships. The third must be fast sea-going vessels of high coal endurance; their office is to stop the enemy's commerce and protect our own; incidentally they fight vessels of their own class and run away from larger ones. The second—the frigates—are intermediate in every respect; their first duty is to accompany and help the fleet of batt'e-ships; incidentally they perform all the duties laid down for sloops. We may arrange the three classes in a table as follows:

	Displacement.	Heaviest Gun.	Heaviest Armor.
Battle-ships....	6,500	12 in.	12 in.
Frigates..... ..	3,500	9 "	6 "
Sloops.....	1,500	6 "	4 "

Now, what does our examination of the types of ships teach us of naval tactics—the tactics of sea-battles? In the first place, will the tactics of battle-ships, frigates, and sloops, whether in single combat or fleet actions, differ? If the tactical features of these classes differ as much as they now do, their tactics must differ; but if their tactical features will be the same, their tactics will be the same, as in former times they were the same. That the frigates and sloops shall approach the battle-ships in tactical features, it is necessary that their armor shall increase, and that they shall carry a heavy gun with a large arc of train; a feature now found in many frigates, as the *Charleston*, *Baltimore*, *Atlanta*, *Chicago*, *Mersey* class, and nearly all French cruisers.

If, then, the tactical features of war-ships of all classes are approaching similarity—the differences being even now more apparent than real—the fighting tactics of all, whether engaged singly or in fleets, will be the same. If the guns of ships are so installed that they have equal all-round fire, they have no preference for one angle of presentment more than another. The line of bearing in fleet formations may then, so far as the question of bringing the guns to bear is concerned, have any direction whatever with respect to the direction in which the enemy is seen. The defensive arrangements of ships—the ratio of their offense to defense on various presentments—will control the range. If these defensive powers approach equality in all directions, as it appears to me logical that they must, if the powers of offense are equal all round, then the gun lays down no tactical rule whatever, except that it prefers that the range should have a certain value. The *Monitors*—to which type the battle-ships of all nations now approach in tactical features—laid down nothing as to the angle of presentment. In a purely gunnery duel between two of them, the only datum we need know, for a complete understanding of the contest, is the range.

A word may be said finally in defense of the use of the old words frigate and sloop, instead of some of the infinity of new names which have been invented to designate vessels whose functions would be the same as those classes. These new names are intended usually to convey something as to the tactical features of a ship—to indicate in some degree how thick her armor is, and how it is disposed; and to show whether her powers of offense are lodged principally in gun, ram, or torpedo. But, as already stated, the existing differences in these respects, except in the matter of armor, are small, and they are growing still smaller; in other words, the sloop of the future may be very nearly produced by a parallel contraction in all respects of the battle-ship.

As to the strain put upon the old meaning of the words sloop and frigate—the meaning with which we are familiar—it is not very great, if we regard the origin of the term. The word frigate passed through a variety of very different meanings, to be applied finally to a ship-rigged war-vessel carrying her guns on one covered deck.

The old term, ship-of-the-line, we have changed to battle-ship; a good name and now firmly lodged in naval terminology. This word alone, among those formerly used to designate different classes of war-ships, has a distinctly military origin. This is probably due to the fact that, of these three classes, the ship-of-the-line alone had a distinctly military origin and purpose.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

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(*Continued from page* 118.)

CHAPTER V.

WOODEN CULVERTS.

On page 214 of Searles's "Field Engineering," paragraph 249, we find the statement, "No wooden culverts should ever be used."

Possibly not, and Mr. Searles might have gone still further and have said that no wooden trestles or wooden bridges should ever be used, as there are undoubtedly serious objections to the use of wood in any of the above-mentioned structures, and iron, steel, or stone would be in every way preferable. But notwithstanding all this, wooden bridges and trestles are used to a great extent, and thousands upon thousands of wooden culverts are in use and continually being built, by our Western railroads in particular.

These culverts undoubtedly give satisfactory results and answer the purpose for which they are constructed, or their use would not be so general upon roads that are not hampered for money and which maintain a high standard of work.

As to the objections to wooden culverts, they are principally as follows:

1. The danger of yielding to the outside pressure of the earth when the wood has become to a certain extent decayed. Any yielding of this nature would not only entirely close the waterway, which would be an exceedingly expensive accident in itself to remedy, but in case of the passage of any great amount of water might lead to various damage to the road in the shape of wash-outs, making a break in the track and thus delaying the traffic.

In case even that there was not sufficient water passing through the culvert at the time to cause any serious damage by itself, still, if the depth of embankment over the top of the culvert was very small, any fall of earth in the culvert would cause a settling of the road-bed to a greater or less extent, and thus cause trouble.

2. The difficulty of examining the timber. This can hardly be called a well-founded objection from the fact that, unless the culvert section is so small that it is impossible for a man to work his way through, this objection can be entirely eliminated by a slight increase in the work of inspection.

When a bank is not of sufficient height to allow of a proper covering over the box culvert, an open culvert is the only remedy; this usually consists of a pile bent on each side of the opening with caps and stringers. The construction of these open culverts will be taken up in detail later. The only point to which we wish to call attention here is that any opening in the track is a most serious objection, and that on a poorly ballasted road, or one with no ballast at all, the objections to openings in the track are increased tenfold, owing to the great difficulty of keeping the track up to grade, particularly at each end of the rigid bearing afforded the rail upon the stringer, so that whenever there is a sufficient height of bank above the top of the culvert, there are many advantages connected with the use of wooden box culverts.

One great drawback to the use of wood in bridges and trestles is the danger from fire. This does not exist in wooden culverts, as they are entirely protected.

One cause that has led to so general a use of wooden culverts, particularly upon new roads of somewhat limited means, is, that they are not only very inexpensive in themselves, but also the ease with which iron pipes can be substituted for them whenever it may be deemed advisable.

In deciding upon the proper size of openings for culverts, the following points must be studied:

1. The area of the water-shed that will empty its water through the culvert.

2. The area of the cross-section of the waterway at the time of the highest known flood.

3. The changes that are liable to take place in any new country, due to the introduction of a railroad and the consequent settling up of the country.

This last-named effect will be shown in two different ways.

1. The swamps will become drained.
2. The smaller streams will entirely disappear.
3. The larger streams will increase in size.

This is due to the facts that not only is the actual number of the streams less, and that all the rain-fall has thus a less number of outlets, but that also very much less of the rain-fall is absorbed by the earth and it is hurried into the streams in much less time than formerly, and thus for a short time increases greatly the amount of water discharged by them. In studying the amount of rain-fall of a section of country in regard to the amount of water that must be passed under the railroad, account should be taken not only of the total number of inches that falls during the entire year, but also of the length of time during which the greater part of the rain falls, because in some sections of country where the total rain-fall is comparatively light, provision on a large scale must still be made for it, owing to the fact that it all comes within a very short time.

Another question to be studied is the topography of the country. In a mountainous section all the rain-fall is precipitated at once into the watercourses, and must be carried off in a short time. This question is one of the most important that has to be studied in connection with the necessary area of waterways.

Many of our American engineers who have worked at different times in tropical countries can fully appreciate the foregoing remarks from sad experience, as the number of culverts on the Mexican railroads that have been carried out during the first rainy season after their construction can be numbered by the hundreds, and this has been due entirely to a failure on the part of the engineers to realize that however small the total amount of rain-fall during the year might be, nearly the whole of this rain-fall came within a very few months, and in some sections was all thrown into the waterways and must be carried off within a few hours after it fell.

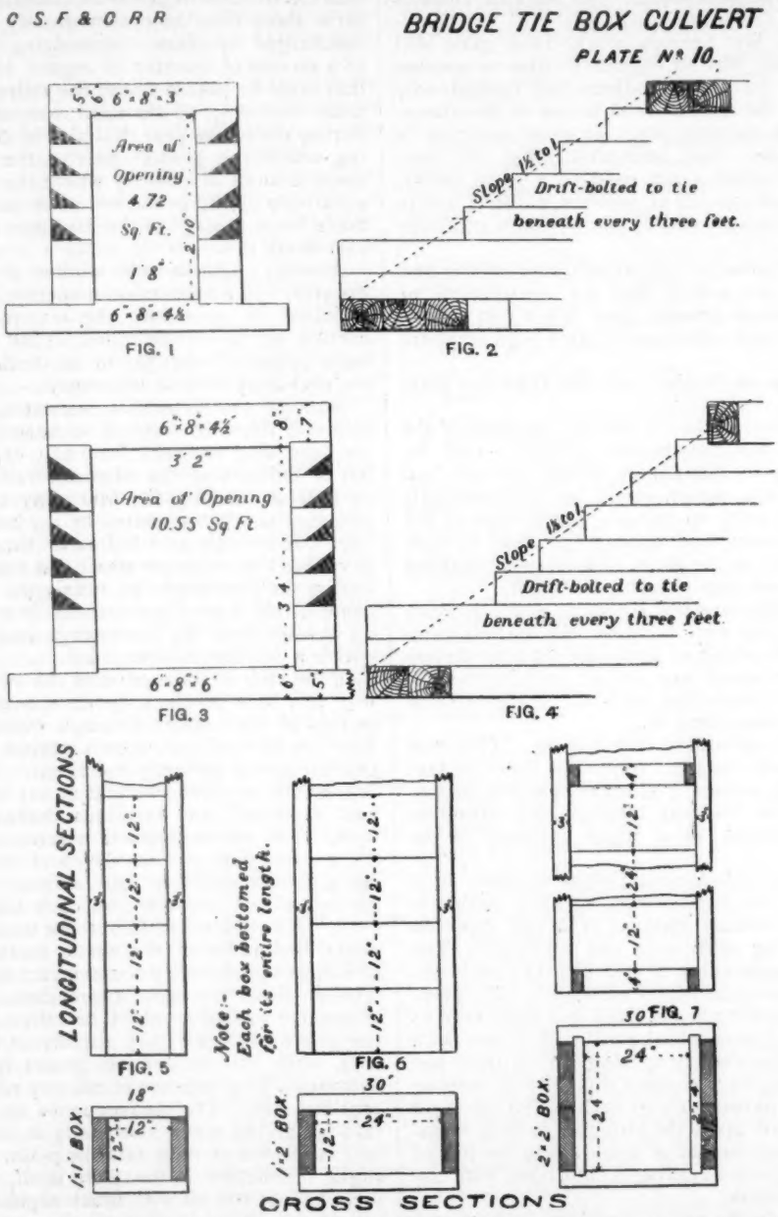
In the case of some parts of the Mexican Central Railway this was particularly deceptive, owing to the cross-section of the country through which the line was built. The line of road ran upon a treeless plain that to all appearances was perfectly horizontal. There were no marks of freshets, or evidences that at any time the watercourses had exercised any injurious damaging effect upon the land. The watercourses themselves were few in number, the greater part of them dry, and those that were not dry contained exceedingly little water. This plain extended for miles east and west on each side of the line of the road. As a matter of fact, there was a uniform, although slight, inclination of the whole surface of this plain, and of course the declivity became very steep when the mountains on either side were approached. The actual section of country was what might be called dish-shaped—that is, the ground falls off very rapidly in the mountainous district, while this inclination grows less and less until it becomes a long expanse of country with scarcely any perceptible fall. The consequence is, that after a heavy rain-fall all the water that falls in the mountainous district is thrown at once into the plain, while, owing to the slight inclination in the plain itself, the water that falls there cannot run off with much rapidity, or, at any rate, it cannot run off until after all the water that has fallen in the mountains has joined it. This effect was very much increased by the building of the railroad embankment, which acted as a dam running the whole length of the plain, and a vast body of water accumulated upon one side of it. This was so great as to wash out hundreds of the culverts during the first rainy season.

The reason that there existed no evidences of the immense amount of water which passed down these valleys, from which the engineer might have drawn just conclusions, was that the inclination of the plain was so slight that however large the body of water was, as long as it had free passage it moved so slowly as not to cause any washing of the surrounding country. In any country

where the inclination of the surface is the opposite of this, the opposite result will be obtained—that is, where the surface of the ground near the culvert has considerable slope which gradually grows less as we leave the culvert, then the water that falls in the immediate vicinity of the culvert is at once passed under the embankment, and the water that falls upon the remainder of this drainage area occupies so much more time in getting to the culvert that there is plenty of space for it to pass through when it gets there. This is one point that should be carefully studied by engineers in deciding upon the sectional area necessary for culverts. One year's experience in Mexico has, however, usually been enough to cause engineers to rush to the other extreme, and in some cases has resulted in a most absurd introduction of trestles, and of culverts of large sectional area.

There are innumerable rules and formulas given in various engineering works upon the subject, for calculating the necessary sectional area of any culvert. These formulas are all based upon the following three variables: 1. The area to be drained. 2. The inclination of this area or the time that will be occupied by the water in getting to the culvert. 3. The amount of rain-fall.

Before using any of these formulas, it is necessary to substitute some values for each one of these variables, and, provided the values of these variables are correct, undoubtedly the resulting sectional area for the culvert will be correct. But as it is impossible to assign any more exact values to these variables than those obtained from the best available data combined with the personal good judgment of the engineer in charge, the result obtained by their use is nothing but guess-work, or good judgment, and it is much easier by the use of this same amount of guess-work or good judgment to decide the sectional area necessary for the culvert without the use of the formulas than it is with them—that is, instead of making three guesses, putting these three guesses in the shape of an empirical formula and calculating the sectional area, there is every probability that as correct a result can be obtained by making one guess as to the required sectional area, multiplying that by 2, and using the result in proportioning the culverts.



In regard to wooden box culverts, they are for so many reasons preferable to open culverts that the rule should be: WHEREVER THE BANK IS OF SUFFICENT HEIGHT, BOX CULVERTS SHOULD ALWAYS BE USED IN PREFERENCE TO OPEN CULVERTS UP TO A CERTAIN SECTIONAL AREA.

Plate 10 shows, in figs. 5, 6, and 7, cross-sections and longitudinal sections of the standard box culverts of 1 ft. × 1 ft., 1 ft. × 2 ft., and 2 ft. × 2 ft. openings, and figs. 1, 2, 3, and 4 show the *Standard Bridge Tie Box Culverts*

of the Chicago, Santa Fé & California Railroad. The methods of construction are clearly shown in the drawings.

The culverts shown in figs. 1 and 3 are built of bridge ties, not because timber of these dimensions possess any inherent advantages, but for the reason that bridge ties can usually be obtained without much trouble, and this is rather an economical and time-saving adaptation of the means to the desired result than a natural result following the use of available means.

Much time and money can often be saved by just such adaptations as this, and a careful study of the different uses to which all available material may be put, either with the mere object of utilizing the material or in case of emergencies, will well repay every engineer.

Plates 10 A and 11 show the *Standard Wooden Box Culverts* of the Chicago, Milwaukee & St. Paul Railway.

The general method of construction is plainly shown in the plans. One point, however, to which we wish to call special attention is that under all circumstances box culverts should be floored throughout their entire length.

This flooring must be watched with care and repaired upon the slightest indication of failure, as upon its completeness depends the whole stability of the culvert.

Care should be taken to protect the upper and lower ends of the culverts in some way from washing.

The flooring should either be extended beyond each end and the sides protected by flaring wings in the shape of sheet piling, or else the upper end should have cobble-stone paving outside. This paving must be raised slightly above the flooring of the culvert, in order to do away with any danger from undermining.

The lower end can in the same way be protected by cobble-stone paving, the top of the paving being slightly below the flooring of the culvert.

Another point to be studied, not only in box culverts, but in all openings for the passage of water under the track, is that the center-line of the culvert should be as nearly at right angles to the center-line of the road as possible, and also that the waterway at each end of the culvert shall be in the prolongation of the axis of the culvert for a sufficient distance each side of the road to diminish the probability of washing in times of exceedingly high water. This point is one of much more importance at the upper end of the culvert than at the lower. If the water-course makes a sharp bend near the entrance of the culvert, there is a strong probability that in time of high water the stream, in place of making this turn and passing through the culvert, will either overflow its ordinary channel or wash its side away and thus impinge upon the railroad embankment and cause a wash-out.

Wooden culverts are built merely as temporary structures to be replaced by iron or stone pipes or stone arches at some future time. This is only following out the general principles upon which the greater part of our American railroads have been constructed. That is, to build the road as cheaply as possible and open it for traffic, then to practically rebuild it out of its earnings. Whether this method is the better one or not is not a question that in most cases will stand discussion, because usually we can build this way or not at all. It is a necessity, not a choice.

In deciding upon the requisite sectional area of wooden box-culverts, they should when possible be given an excess of area sufficient to allow of the introduction of an iron pipe when desired, by simply removing the bottom.

When there is sufficient depth of fill over them, however, to absorb all the force of impact of the passing trains, then, if they have been in use a number of years so that the bank is well compacted, the entire wooden box can be removed with very little danger of any caving in of the earth. Under all circumstances, however, the iron pipe should be put in place as rapidly as possible and the earth well packed around it.

Where a stone arch is not going to be constructed, an iron pipe is in every way preferable to an earthen or stonepipe, owing to the much greater liability of the latter to break.

Below are given bills of the material required in the construction of each of the culverts shown, on a single-track road with road-bed 14 ft. wide. These bills of material are made out for heights of bank from 5 ft. to 30 ft., measuring from profile grade to bottom of culvert.

BILLS OF MATERIAL FOR CULVERTS FOR STATED DEPTHS BELOW GRADE.

No. 13. Bridge-Tie Culverts.—Plate 10, Figs. 1, 2, 3, and 4.

Depth from Grade to Bottom of Opening.	14 ft. Roadway. No. 1. Ties, 6 in. × 8 in. × 18 ft.	14 ft. Roadway. No. 1. 12-in. Drift-bolts, ¾" dia.	14 ft. Roadway. No. 2. Ties, 6 in. × 8 in. × 18 ft.	14 ft. Roadway. No. 2. 12-in. Drift-bolts, ¾" dia.	16 ft. Roadway. No. 1. Ties, 6 in. × 8 in. × 18 ft.	16 ft. Roadway. No. 1. 12-in. Drift-bolts, ¾" dia.	16 ft. Roadway. No. 2. Ties, 6 in. × 8 in. × 18 ft.	16 ft. Roadway. No. 2. 12-in. Drift-bolts, ¾" dia.
5 ft.	35	254	50	278	40	274	60	312
10 ft.	56	453	75	460	60	418	80	438
15 ft.	76	556	100	627	80	580	100	654
20 ft.	96	694	125	802	100	718	130	808
25 ft.	116	858	152	982	120	868	160	1,002
30 ft.	136	1,000	178	1,150	138	1,018	185	1,176

Note.—Pieces for roof are not to be cut until walls are laid. Put no pieces in the walls less than 6 ft. long. A 6-ft. piece should have 3 drift-bolts.

No. 14. Wooden Culvert.—Plate 10, Figs. 5, 6, and 7.
For 14-ft. roadbed: All material 12 in. × 3 in.

Depth of Fill.	Length of Culvert.	Section 1 ft. × 1 ft.	Section 1 ft. × 2 ft.	Section 2 ft. × 2 ft.	2 in. × 4 in. × 2 ft. 4 in.
		5 lin. ft. per ft. of Length.	7 lin. ft. per ft. of Length.	9 lin. ft. per ft. of Length.	
		Linear ft.	Linear ft.	Linear ft.	
5 ft.	30 ft.	150	210	270	14 pcs.
10 ft.	45 ft.	225	315	405	24 pcs.
15 ft.	60 ft.	300	420	540	32 pcs.
20 ft.	75 ft	375	525	675	38 pcs.
25 ft.	90 ft.	450	630	810	46 pcs.
30 ft.	105 ft.	525	735	945	54 pcs.

No. 15. Wooden Culvert.—Plate 10A, Figs. 1 and 7.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade. Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 5 ft. 4 in. Sills....	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor.....	12	18	24	30	36	42
8 in. × 12 in. × 15 ft. Sides	4	8	12	16	20	24
8 in. × 12 in. × 13 ft. 6 in. Sides...	4	4	4	4	4	4
12 in. × 8 in. × 6 ft. Top.....	5	8	10	13	15	18
6 in. × 12 in. × 6 ft. "	22	34	47	59	72	84
¾ in. × 20 in. Bolts.....	18	28	36	44	54	64

No. 16. Wooden Culvert.—Plate 10A, Figs. 2 and 7.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade. Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 6 ft. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor.....	14	21	28	35	42	49
8 in. × 12 in. × 15 ft. Sides.....	4	8	12	16	20	24
8 in. × 12 in. × 13 ft. 6 in. Sides..	4	4	4	4	4	4
8 in. × 12 in. × 4 ft 8 in. Top..	5	8	10	13	15	18
6 in. × 12 in. × 4 ft. 8 in. "	22	34	47	59	72	84
¾ in. × 20 in. Bolts...	18	28	36	44	54	64

C. M. & St. P. R. R. TIMBER BOX CULVERTS.

Covering, 6"

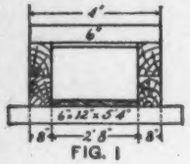


FIG. 1

Covering, 6"

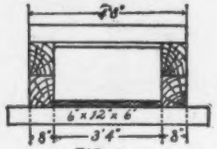


FIG. 2

Height of Bank	Covering.
Up to 25 ft.	6 in.
Over 25 ft.	8 in.

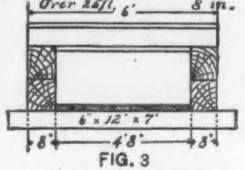


FIG. 3

PLATE No. 10, A.

Covering, 6"

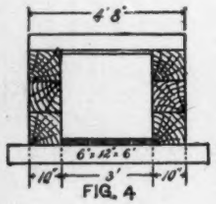


FIG. 4

Covering, 6"

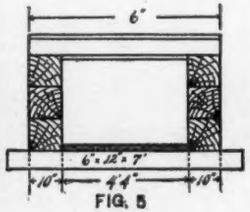


FIG. 5

Height of Bank.	Covering
Up to 15 ft.	6 in.
15 ft. to 25 ft.	8 in.
25 ft. and over	10 in.

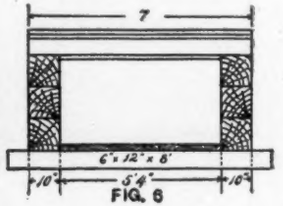


FIG. 6

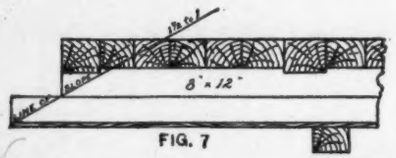


FIG. 7

FIG. 8

Every Sixth Stick 8" Thick and Notched 2".
Side Timbers Bolted every 6' with ¾" x 20" Drift Bolts.
6" x 12" Sills, not more than 8' Centre to Centre.

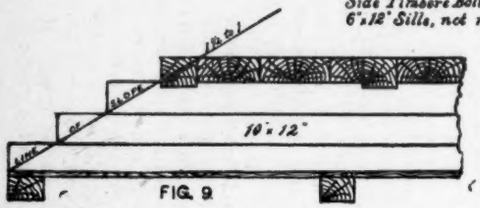


FIG. 9

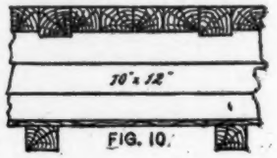


FIG. 10.

C. M. & St. P. R. R. TIMBER BOX CULVERTS.

PLATE No. 11.

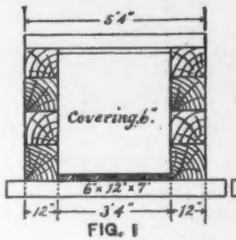


FIG. 1

FIG. 2

FIG. 3

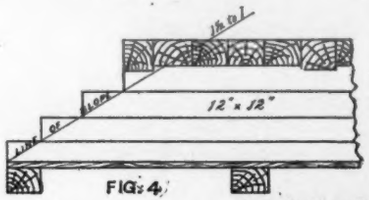


FIG. 4

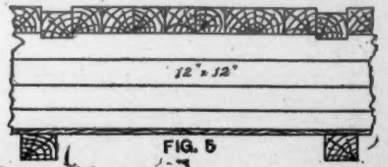


FIG. 5

Every Sixth Stick 8" Thick and Notched 2".
Side Timbers Bolted every 6' with ¾" x 20" Drift Bolts.
6" x 12" Sills, not more than 8' Centre to Centre.

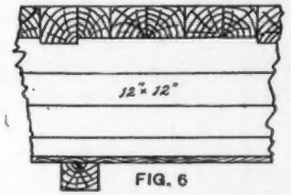


FIG. 6

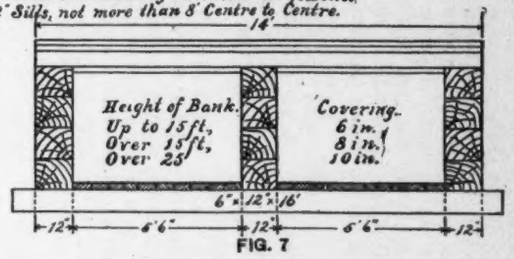


FIG. 7

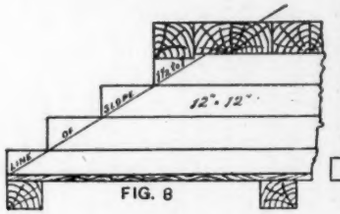


FIG. 8

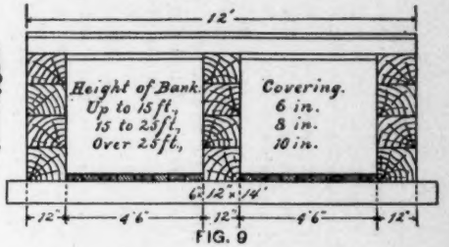


FIG. 9

No. 17. Wooden Culvert.—Plate 10A, Figs. 3 and 7.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 7 ft. Sills.	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor.	18	27	36	45	54	63
8 in. × 12 in. × 15 ft. Sides.	4	8	12	16	20	24
8 in. × 12 in. × 13 ft. 6 in. Sides	4	4	4	4	4	4
8 in. × 12 in. × 6 ft. Top	5	8	10	13	15	102
6 in. × 12 in. × 6 ft. "	22	34	47	59	72	"
¾ in. × 20 in. Bolts	18	28	36	44	54	64

No. 18. Wooden Culvert.—Plate 10A, Figs. 4 and 9.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 6 ft. Sills.	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor.	12	18	24	30	36	42
10 in. × 12 in. × 15 ft. Sides.	4	10	16	22	28	34
10 in. × 12 in. × 13 ft. 6 in. Sides	4	4	4	4	4	4
10 in. × 12 in. × 12 ft. Sides.	4	4	4	4	4	4
8 in. × 12 in. × 4 ft. 8 in. Top.	5	7	9	12	14	17
6 in. × 12 in. × 4 ft. 8 in. "	16	29	42	54	67	79
¾ in. × 20 in. Bolts.	28	40	54	68	82	96

No 19. Wooden Culvert.—Plate 10A, Figs. 5 and 9.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 7 ft. Sills.	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor	18	27	36	45	54	63
10 in. × 12 in. × 15 ft. Sides.	4	10	16	22	28	34
10 in. × 12 in. × 13 ft. 6 in. Sides	4	4	4	4	4	4
10 in. × 12 in. × 12 ft. Sides.	4	4	4	4	4	4
8 in. × 12 in. × 6 ft. Top	5	7	9	12	14	17
6 in. × 12 in. × 6 ft. "	16	29	42	54	67	79
¾ in. × 20 in. Bolts.	28	40	54	68	82	96

No. 20. Wooden Culvert.—Plate 10A, Figs. 6 and 9.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 8 ft. Sills.	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor.	22	33	44	55	66	77
10 in. × 12 in. × 15 ft. Sides.	4	10	16	22	28	34
10 in. × 12 in. × 13 ft. 6 in. Sides.	4	4	4	4	4	4
10 in. × 12 in. × 12 ft. Sides.	4	4	4	4	4	4
10 in. × 12 in. × 7 ft. Top.	..	..	..	12	14	105
8 in. × 12 in. × 7 ft. "	5	7	9	54	67	..
6 in. × 12 in. × 7 ft. "	16	29	42	..	..	..
¾ in. × 20 in. Bolts.	28	40	54	68	72	96

No. 21. Wooden Culvert.—Plate 11, Figs. 1 and 4.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 7 ft. Sills.	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor.	14	21	28	35	42	49
12 in. × 12 in. × 15 ft. Sides.	4	12	20	28	36	44
12 in. × 12 in. × 13 ft. 6 in. Sides.	4	4	4	4	4	4
12 in. × 12 in. × 12 ft. Sides.	4	4	4	4	4	4
12 in. × 12 in. × 10 ft. 6 in. Sides.	4	4	4	4	4	4
8 in. × 12 in. × 5 ft. 4 in. Top.	4	6	9	11	14	16
6 in. × 12 in. × 5 ft. 4 in. "	14	27	39	52	64	77
¾ in. × 20 in. Bolts.	34	52	70	90	110	130

No. 22. Wooden Culvert.—Plate 11, Figs. 2 and 4.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 7 ft. Sills.	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floors.	16	24	32	40	48	56
12 in. × 12 in. × 15 ft. Sides.	4	12	20	28	36	44
12 in. × 12 in. × 13 ft. 6 in. Sides.	4	4	4	4	4	4
12 in. × 12 in. × 12 ft. Sides.	4	4	4	4	4	4
12 in. × 12 in. × 10 ft. 6 in. Sides.	4	4	4	4	4	4
10 in. × 12 in. × 6 ft. Top.	..	..	..	..	..	16
8 in. × 12 in. × 6 ft. "	4	6	9	11	14	77
6 in. × 12 in. × 6 ft. "	14	27	39	52	64	..
¾ in. × 20 in. Bolts.	34	52	70	90	110	130

No. 23. Wooden Culvert.—Plate 11, Figs. 3 and 4.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 8 ft. Sills.	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor.	20	30	40	50	60	70
12 in. × 12 in. × 15 ft. Sides.	4	12	20	28	36	44
12 in. × 12 in. × 13 ft. 6 in. Sides.	4	4	4	4	4	4
12 in. × 12 in. × 12 ft. Sides.	4	4	4	4	4	4
12 in. × 12 in. × 10 ft. 6 in. Sides.	4	4	4	4	4	4
10 in. × 12 in. × 7 ft. Top.	..	..	..	11	14	93
8 in. × 12 in. × 7 ft. "	4	6	9	52	64	..
6 in. × 12 in. × 7 ft. "	14	27	39	..	..	..
¾ in. × 20 in. Bolts.	34	52	70	90	110	130

CHAPTER VI.

HAND-CAR AND TOOL HOUSES.

Plate 12, figs. 1, 2, 3, 4 and 5, show plans and elevation of the *Standard Hand-Car and Tool House* of the Chicago, Milwaukee & St. Paul Railway.

The object of these houses is to hold the hand-car and all the tools and small material used by a section gang.

A house of the size shown in the plate is sufficient for all purposes of storage of the car, tools, spikes, bolts, etc., and also to allow the men to move around with ease and carry on any work that may be desirable.

As shown in the plate, these houses are furnished with a stove and have a window in one end. They should be

WATCHMANS HOUSE.

PLATE Nº 13.

ATCHISON, TOPEKA & SANTA FE R.R.

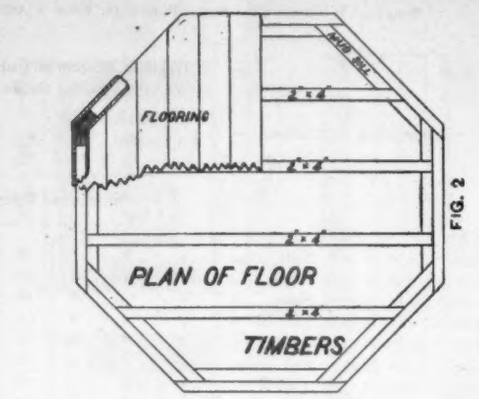


FIG. 2

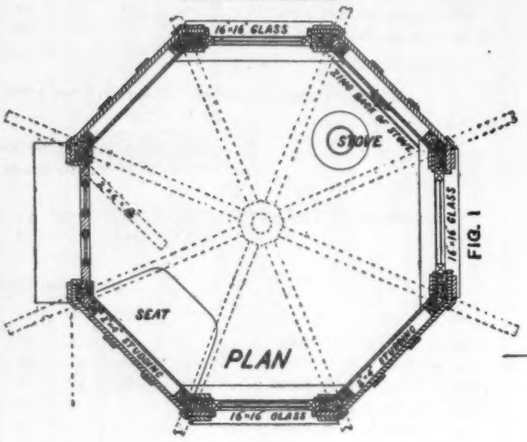


FIG. 1

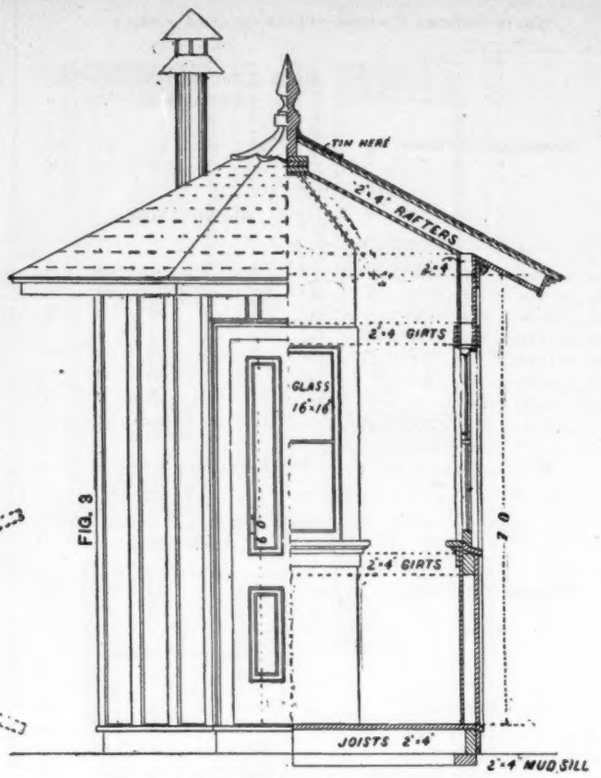


FIG. 3

HALF ELEVATION HALF SECTION

C M & St. P Ry.

PLATE Nº 12.

HAND CAR AND TOOL HOUSE.

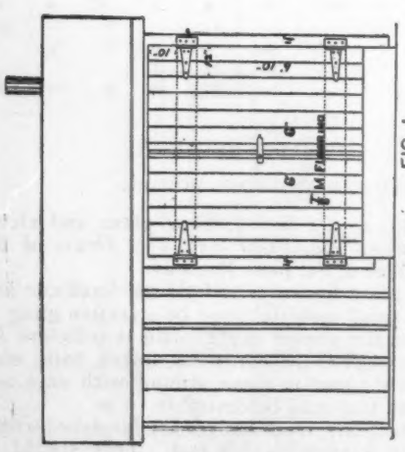
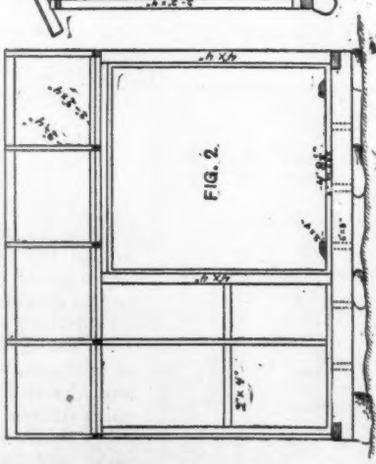
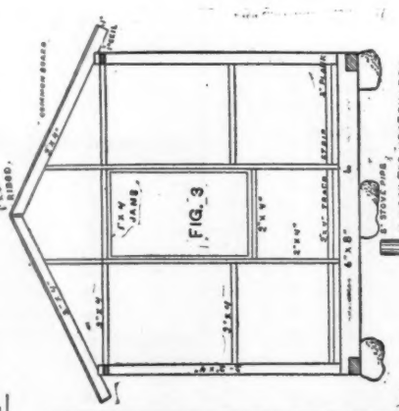
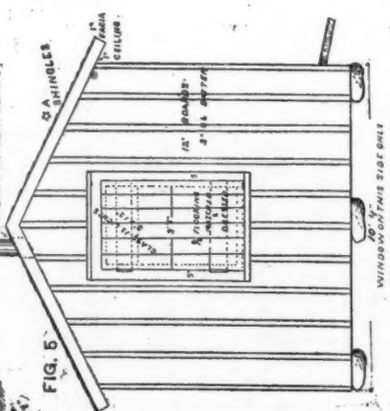
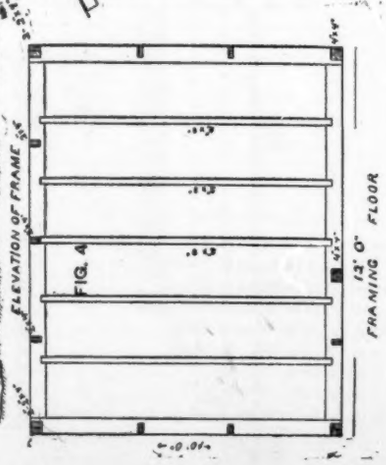


FIG. 1









No. 24. Wooden Culvert.—Plate 11, Figs. 6 and 7.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 12 in. × 16 ft. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor	44	66	88	110	132	154
12 in. × 12 in. × 15 ft. Sides	6	18	30	42	54	66
12 in. × 12 in. × 13 ft. 6 in. Sides	6	6	6	6	6	6
12 in. × 12 in. × 12 ft. Sides	6	6	6	6	6	6
12 in. × 12 in. × 10 ft. 6 in. Sides	6	6	6	6	6	6
10 in. × 12 in. × 14 ft. Top	..	..	..	11	14	93
8 in. × 12 in. × 14 ft. "	4	6	9	52	64	..
6 in. × 12 in. × 14 ft. "	14	27	39	..	..	..
¾ in. × 20 in. Bolts	34	52	70	90	110	130

No. 25. Wooden Culvert.—Plate 11, Figs. 8 and 9.

Dimensions of Timber.	Depth of Bottom of Culvert Below Profile Grade.					
	Ft. 5	Ft. 10	Ft. 15	Ft. 20	Ft. 25	Ft. 30
	Number of Pieces.					
6 in. × 8 in. × 14 in. Sills	4	6	8	10	12	14
2 in. × 6 in. × 15 ft. Floor	36	54	72	90	108	126
12 in. × 12 in. × 15 ft. Sides	6	18	30	42	54	66
12 in. × 12 in. × 13 ft. 6 in. Sides	6	6	6	6	6	6
12 in. × 12 in. × 12 ft. Sides	6	6	6	6	6	6
12 in. × 12 in. × 10 ft. 6 in. Sides	6	6	6	6	6	6
10 in. × 12 in. × 12 ft. Top	..	..	..	11	14	93
8 in. × 12 in. × 12 ft. "	4	6	9	52	64	..
6 in. × 12 in. × 12 ft. "	14	27	39	..	..	..
¾ in. × 20 in. Bolts.	34	52	70	90	110	130

provided with a bench across one end, and with a number of lockers.

They should stand parallel with the track and at a sufficient distance from it to allow of the hand-car standing between them and the track, without any danger of being struck by passing trains. The rails of the car-house should be below the level of the main track, in order to eliminate all possibility of the car getting loose and running on to the track.

The door of the house can be either hung on hinges, as shown in the plate, or else be a sliding door. There are advantages connected with the use of both, but leaving the slight increase of expense out of the question, the sliding doors are, on the whole, preferable.

When possible, the house should stand next to a side track rather than to the main line, so that in removing the car from the track the section men are in no way interfering with the main line.

When the siding, however, is much used and there is a liability of its being occupied the greater part of the time by cars, then it is not possible to have the house stand next to it, owing to the great inconvenience and loss of time it would occasion the section men.

No. 26. Bill of Material for Hand Car and Tool House.

Plate No. 12.

2 pieces ..... 6 in. × 8 in. × 10 ft.
2 pieces ..... 6 in. × 8 in. × 12 ft.
5 pieces ..... 2 in. × 8 in. × 9 ft. 6 in.
9 pieces ..... 2 in. × 4 in. × 8 ft.
2 pieces ..... 4 in. × 4 in. × 8 ft.
7 pieces ..... 2 in. × 4 in. × 10 ft.
2 pieces ..... 2 in. × 4 in. × 3 ft. 6 in.
1 piece ..... 2 in. × 4 in. × 12 ft.
1 piece ..... 2 in. × 4 in. × 5 ft.
10 pieces ..... 2 in. × 4 in. × 7 ft. rafters.
4 pieces ..... 1 in. × 4 in. × 7 ft. facia.
2 pieces ..... 1 in. × 4 in. × 13 ft. facia.
1 piece ..... 1 in. × 5 in. × 13 ft. ridge.
4 pieces ..... 2 in. × 4 in. × 12 ft. plates.
500 ft. B. M. 1-in. boards, 12 in. wide.
2 ft. B. M. 2 in. × 4 in. × 10 ft. track strip.
240 ft. B. M. 2-in. plank floor.
325 lin. ft. 2-in. battens.
1 double door, 6 ft. 6 in. wide × 7 ft. long, made of ⅞-in. matched flooring.
1 window sash, 12 lights, 9 in. × 12 in.
1 window shutter, ⅞-in. matched flooring.
4 door hinges with 12-in. strap, as per drawing.
2 door hinges.
1 hasp and staple for door.
1 hook for shutter.
1 piece zinc 2 ft. 6 in. × 3 ft.
10 lbs. 4 d. nails.
¼ keg 8 d. nails.
¼ keg 10 d. nails.
13 lbs. paint.
500 A. shingles or galvanized corrugated iron.
Tin box for heat guard.

CHAPTER VII.

WATCHMAN'S HOUSES.

Plate 13 shows the plan and elevation of an octagonal *Watchman's House*, as built upon the Atchison, Topeka & Santa Fé Railroad.

These houses are required to be large enough simply to accommodate the watchman and afford a place for a stove, in case the climate is such as to necessitate the use of one. They are situated at switches, road crossings, or any other place where it is necessary to have a watchman, and as he must of necessity be inside the house during inclement weather, one point that should be carefully studied is a sufficiency of windows to allow him a clear view of the track in both directions and also of the road crossing and whatever else it may be his duty to watch. This is accomplished in a most economical and satisfactory fashion by making the house octagonal, as shown in the drawing. Then the space occupied by the stove does not obstruct the view in any direction, and the windows, together with the door, permit a clear view in every direction.

Another point that should be studied in the construction of this house is that the framing should be put together in such a manner that the house may be moved from one point to another the same as a box, whenever the occasion requires. In this regard, also, the octagonal shape possesses a great many advantages over the ordinary rectangular form.

It is better to make the roofs of these houses of corrugated galvanized iron, as it decreases the risk from fire.

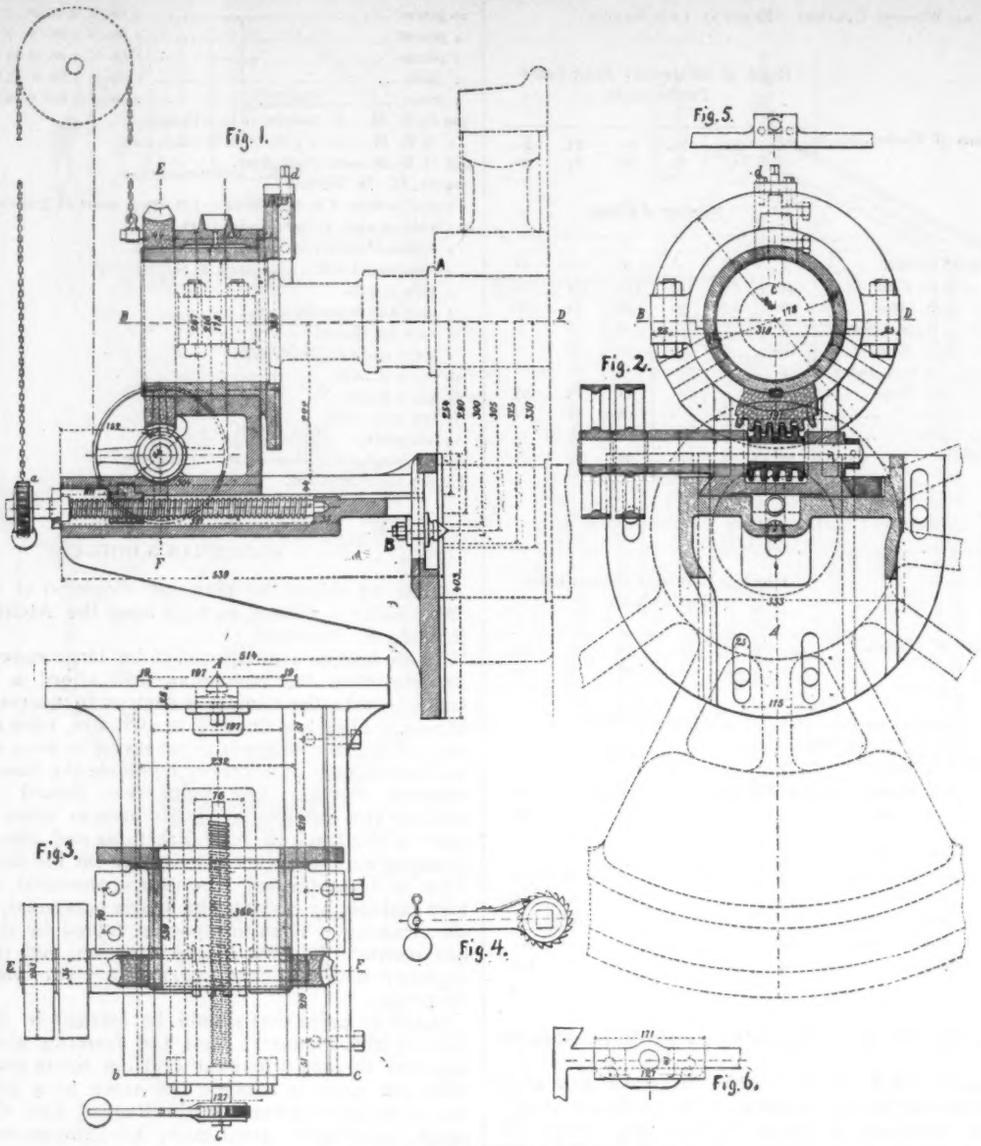
No. 27. Bill of Material for Watchman's House, 6 ft. Diameter.

Plate No. 13, Figs. 1, 2, and 3.

4 pieces sills and mud sills ..... 2 in. × 4 in. × 12 ft.
1 piece sills and mud sills ..... 2 in. × 4 in. × 16 ft.
2 joists ..... 2 in. × 4 in. × 18 ft.
8 studs ..... 2 in. × 4 in. × 14 ft.
3 girts and plates ..... 2 in. × 4 in. × 14 ft.
1 octagon cap for rafters to butt on at apex of roof ..... 8 in. diam. out of 3 pieces of plank.
1 turned terminal ..... 5 in. diam. and 22 in. high.
130 ft. B. M. 1 in. × 10 in. × 16 ft. for outside.
160 ft. B. M. ⅝ in. × 6 in., beaded sheathing.
80 ft. B. M. roofing boards.
800 star shingles.
21 lin. ft. 1 in. × 6 in. frieze board.
21 lin. ft. moulding No. 159, H. & W.
62 ft. B. M. ⅞ in. × 6 in., flooring for soffit of eaves and floor.
10 O. G. battens, 3 in. × 16 ft. long, outside.
28 lin. ft. ⅞ in. × 4 in. facia.
28 lin. ft. moulding No. 31, H. & W.

Doors and Windows.

1 door ..... 2 ft. × 6 ft. × 1¾ in. four-panel raised O. G.
1 sill ..... ⅞ in. × 10 in. × 2 ft. 6 in.
1 jamb ..... ⅞ in. × 3⅝ in. × 12 ft.
1 head ..... ⅞ in. × 3⅝ in. × 2 ft. 4 in.
1 outside casing ..... ⅞ in. × 4 in. × 12 ft.



URQUHART'S CRANK-PIN LATHE.

1 head	⅞ in. × 4 in. × 3 ft.
1 inside casing	⅞ in. × 4 in. × 12 ft.
1 head	⅞ in. × 4 in. × 3 ft.
3 sashes	1¾ in., 2 lights, 16 in. × 16 in. glass.
3 outside casings	⅞ in. × 4 in. × 7 ft. 6 in.
3 heads	⅞ in. × 4 in. × 2 ft. 4 in.
3 outside stops	⅝ in. × 1⅜ in. × 8 ft.
3 rabbitted sills	1¾ in. × 4 in. × 2 ft. 4 in.
3 inside casings	⅞ in. × 4 in. × 7 ft. 6 in.
3 heads	⅞ in. × 4 in. × 2 ft. 4 in.
3 inside sills	⅞ in. × 3½ in. × 2 ft. 8 in.
3 apron pieces	⅞ in. × 4 in. × 2 ft. 4 in.
1 piece moulding No 61, H. & W., 7 ft long.	

Hardware.

1 rural night latch, left hand.
1 left-hand thumb latch.
1 piece zinc, 2 ft. 6 in. × 2 ft. 8 in.
¼ keg 10 d. nails.
¼ keg 8 d. nails.
7 lbs. 4 d. nails.
10 ft. flashing tin, 14 in. wide.

Paint.

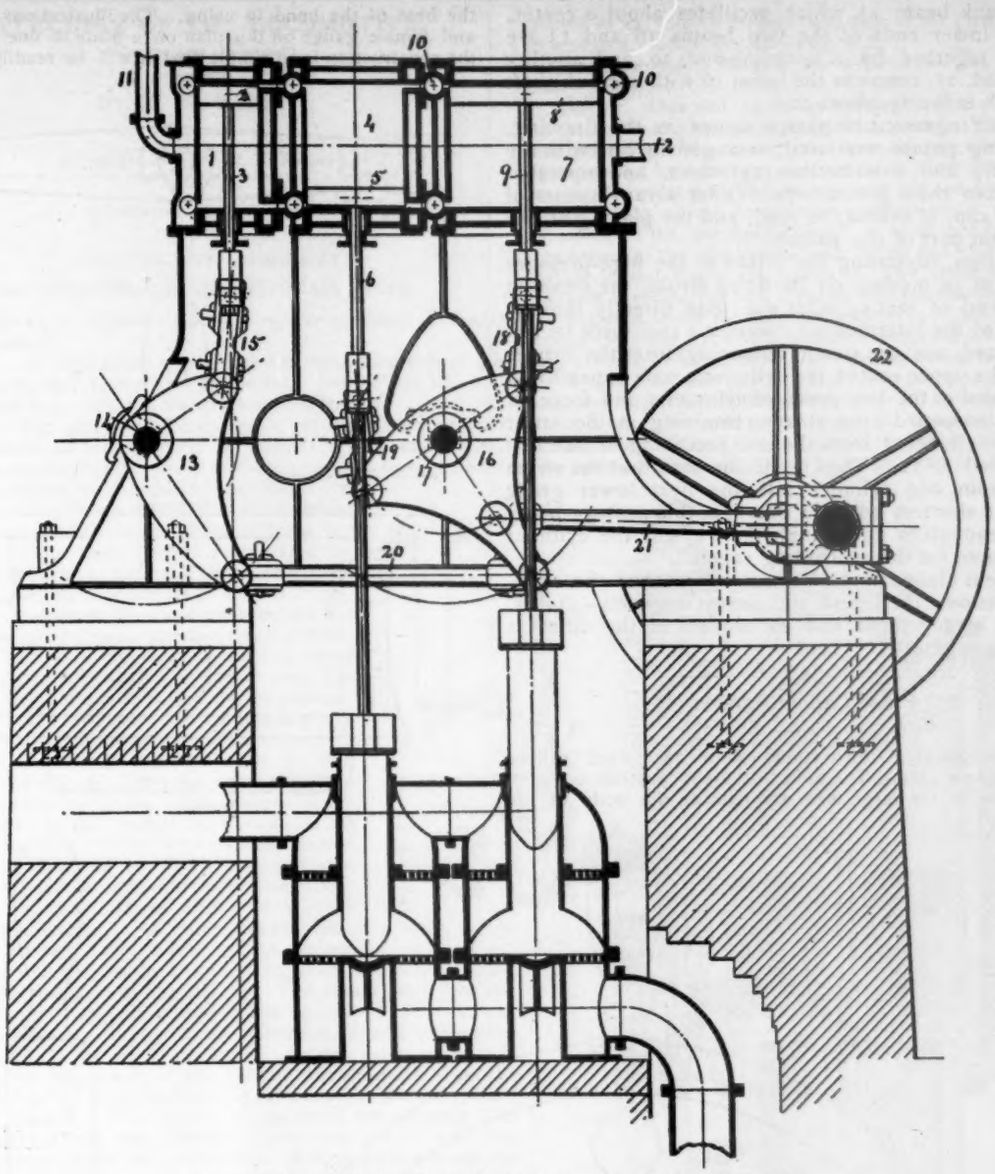
3 gals. Asbestos paint.
1 gal. boiled linseed-oil.
5 lbs. putty.

The amount of expense that may be justifiable in order to ornament and beautify these houses depends entirely upon the location of the house, although from a standpoint of economy, the house should always be neatly painted and everything about it should be kept as neat and clean as possible. This principle not only applies to watchmen's houses, but to all other buildings connected with a railroad, and even if it necessitates a little additional expense, this expense is well repaid to the road in actual saving of material. Under all circumstances, order and neatness should be inculcated in railroad employés. The mere fact that a watchman is obliged to sweep out his house every day and keep everything picked up, not only preserves the house, but makes him in every respect a better and more trustworthy watchman.

(TO BE CONTINUED.)

A MACHINE FOR TURNING UP LOCOMOTIVE CRANK-PINS.

THE accompanying illustrations show a very neat and convenient tool for turning up locomotive crank-pins, designed by Mr. Thomas Urquhart, Chief Mechanical Engineer of the Griasi-Tzaritzin Railroad. Several of these machines are now, and have been for some time, in use on that road, with excellent results, and the machine has



GASKILL'S TRIPLE-EXPANSION PUMPING ENGINE.

been patented by Mr. Urquhart, both in Europe and in this country.

In the accompanying illustrations, fig. 1 is a cross-section on the line *A C*, figs. 2 and 3; fig. 2 is a section on the line *E F*, figs. 1 and 3; fig. 3 is a section on the line *E D*, figs. 1 and 2; fig. 4 is a side view of the ratchet, the end view of which is shown on the left of fig. 1; fig. 5 is a plan of *d*, figs. 1 and 2; fig. 6 is a view of *a b*, fig. 3.

The construction of this tool is very simple, and can be readily understood from the drawings. The general plan of the machine is an angular bed-plate of cast iron, which serves as a support for the gearing, and a ring-shaped head carrying the cutting tool and the gearing, from which it derives its motion, through a worm-wheel and worm carried on the main shaft, which is driven by a belt. The bed-plate can be fastened to the driving-wheel by means of clamping bolts passing between the spokes of the wheel.

In use the machine is set true to the unworn collar *A* at the base of the crank-pin; the movable center *B* can be arranged for any radius of crank. The head-stock makes from 4 to 4½ revolutions per minute.

The Griasi-Tzaritzin Railroad is about 500 miles in length and is equipped with 143 locomotives, 60 of which have eight wheels coupled. Two of these tools, at the Central Shops in Borisoglebsk, keep all the worn crank-pins in excellent order, the almost absolute correctness of the centers of the pins when trued up being remarkable, while the finish given by the spring tool is excellent. We are informed that the saving in crank-pins, connecting-rod brasses, and in oil is very considerable, while the engines run with unusual smoothness, and pounding and heating of brasses is almost unknown.

A TRIPLE-EXPANSION PUMPING ENGINE.

THE accompanying illustration shows a design for a triple expansion engine, recently patented by Mr. Harvey F. Gaskill, of Lockport, N. Y. The drawing is a vertical section through the cylinders, showing also the pumps, the foundation, and the peculiar arrangement of cranks.

The object of Mr. Gaskill's design is to make the steam passages between the cylinders short and direct, dispensing with intermediate receivers. It will be seen from the illustration that the cylinders are so arranged and connected that the pistons 2 and 8 of the high and low-pressure cylinders move together, while the piston 5 of the intermediate cylinder moves in an opposite direction to the other two. By this arrangement steam is exhausted directly from the end of the cylinder in which it has just done its work into the cylinder of the next succeeding grade.

The connecting rods of the low-pressure and intermediate cylinders are coupled to a triangular beam, 16, which oscillates about the center 17, while the high-pressure cylinder connects by a link or short connecting rod with

the bell-crank beam 13, which oscillates about a center, 14. The lower ends of the two beams 16 and 13 are connected together by a coupling-rod, 20, and another coupling-rod, 21, connects the beam 16 with a crank-shaft upon which is the fly-wheel 22.

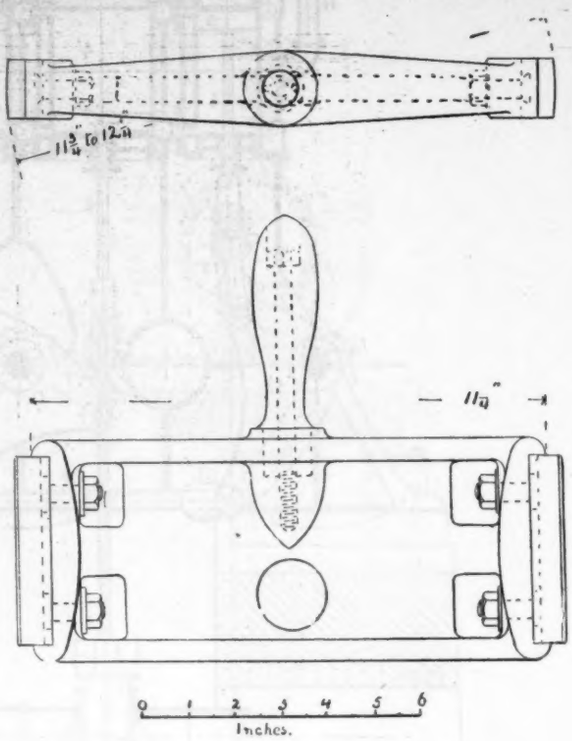
In the arrangement of pumps shown in the drawing, single-acting pumps are used, arranged in line with the low-pressure and intermediate cylinders, and operated directly from their piston-rods. Other arrangements of the pumps can, of course, be used, and the placing of the pumps is not part of the patent.

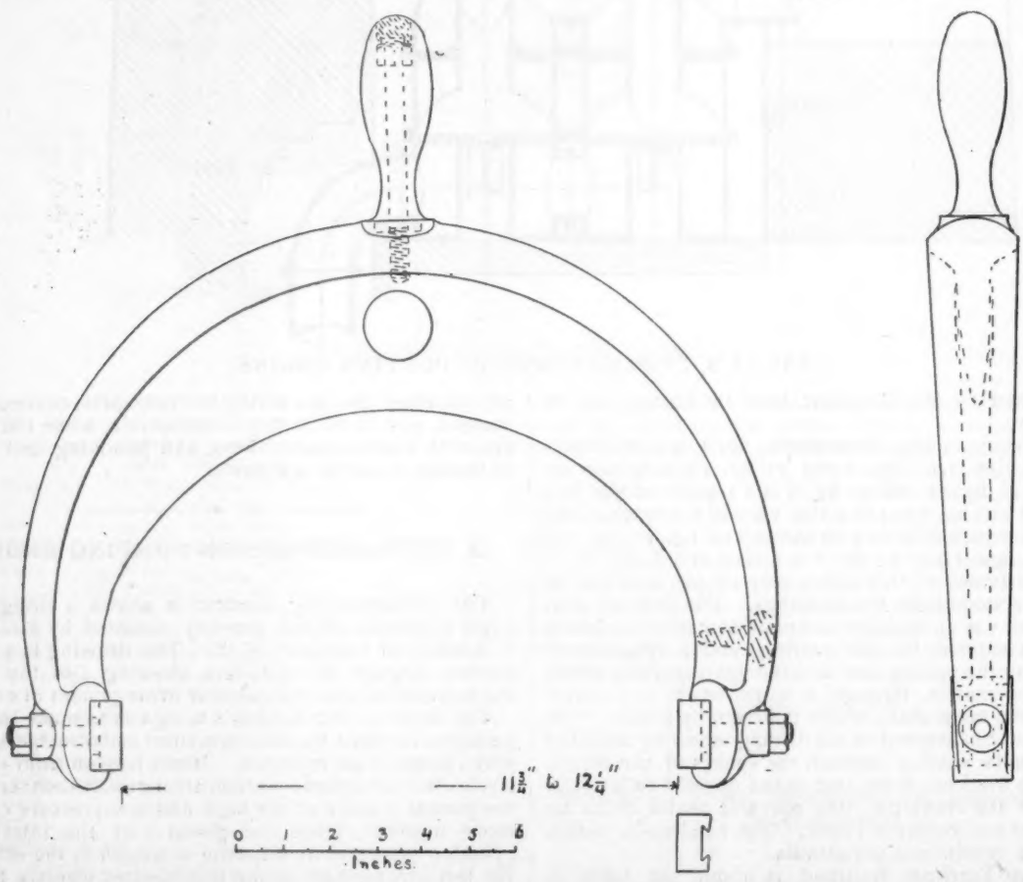
In operation, supposing the piston of the high-pressure cylinder 1 to be moving on its down stroke, the steam in the lower end of that cylinder will pass directly into the lower end of the intermediate cylinder 4 and force its piston 5 upward, and the steam remaining from the former stroke in the upper end of the cylinder 4 will expand into the upper end of the low-pressure cylinder 7 and force its piston 8 downward; the steam remaining in the lower end of the cylinder 7 from the last preceding stroke will be exhausted at 12. Thus it will be seen that the steam expands from one cylinder into the next lower grade through the shortest possible passage, this passage being only long enough to go through the walls of the cylinder and give room for the controlling valve.

The patent claims cover the arrangement of the cylinders and pistons, the beams and connecting-rods—that is, simply the arrangement and connection of the different parts of the engine.

Fixed Caliper Gauges.

THE accompanying illustrations show two fixed caliper gauges on a new plan. The object of their construction is to save expense in the large sizes by making the body of the gauge of cast iron, the heels and points being made of steel fitted to these bodies, hardened and ground to size. This arrangement has the further advantage that the heels and points can be renewed from time to time, as required. The handles are made of wood and the gauge is therefore less affected by the heat of the hand in using. The illustrations show a male and female gauge on this plan on a scale of one-quarter size; the construction is so simple that it will be readily understood from the drawings. As will be seen, the heels and points are fastened to the body of the gauge by bolts, making their adjustment easy.





These gauges are made by James A. Taylor & Company at the American Standard Gauge & Tool Works, Wilmington, Del.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

By M. N. Forney.

(Copyright, 1887, by M. N. Forney.)

[*(Continued from page 141.)*

CHAPTER XXV. *(Continued.)*

THE WESTINGHOUSE AUTOMATIC AIR BRAKE.

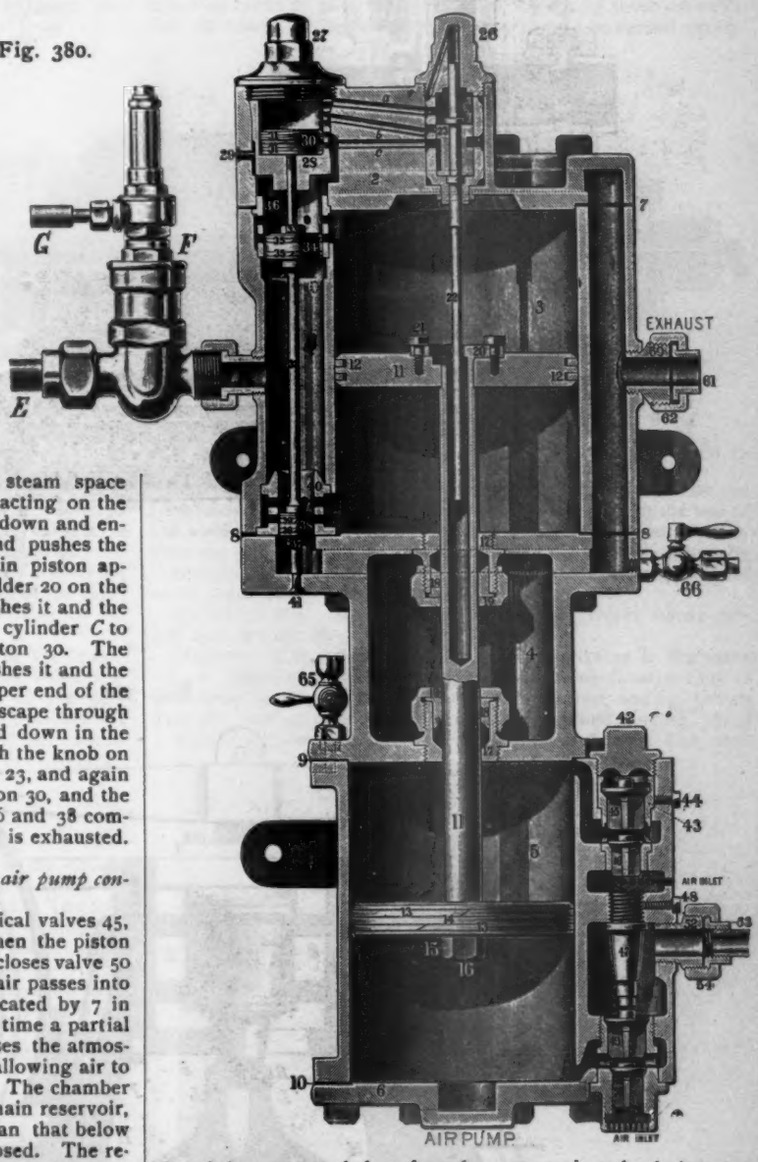
Question 651. *Where is the air pump for operating the brakes usually located?*

Answer. It is generally attached to the right-hand side of the fire-box or further forward on the boiler. See 1 Plate VI.

Question 652. *How is the air pump constructed?*

Answer. Fig. 380, which represents a vertical section of such a pump, shows its construction. It consists of a steam cylinder, 3, and an air cylinder, 5. Both of these cylinders have pistons, 11 and 14, which are connected together by a piston-rod, 11. Steam taken from the locomotive boiler is admitted to the upper cylinder by a pipe, *A*. The upper piston is operated by the steam pressure in the cylinder 3, and moves the lower one, which compresses the air in cylinder 5. The steam from the boiler enters the upper cylinder between the two small piston-valves 34 and 38. The upper piston 34 being of greater diameter than the lower one, the tendency of the pressure is to raise the pistons, unless they are held down by the pressure of a third piston, 30, of still greater diameter, which works in a cylinder directly above 34, and bears on the rod 32. The pressure on this third piston is regulated by the small slide-valve 23, which works in the central chamber 24 on the top cylinder-head. This valve receives its motion from a small rod, 22, which is connected to the valve 23 and extends into the hollow piston-rod 11. The small rod has a knob on its lower end and a shoulder, *S*, just below the top head. A steam passage, not shown in the engraving, connects the valve chamber 24 with the steam space *B* between the pistons 34 and 38. The steam acting on the third piston 30 holds the piston-valves 34 and 38 down and enters the cylinder 3 through the openings at 40 and pushes the main piston 11 up in its cylinder. As the main piston approaches the upper end of the cylinder the shoulder 20 on the piston strikes the shoulder *S* on the rod 22 and pushes it and the valve 23 upward. This allows the steam in the cylinder *C* to escape and relieve the pressure above the piston 30. The steam pressure below the piston-valve 34 then pushes it and the valve 38 upward, which admits steam into the upper end of the cylinder 3, and also allows that in the lower end to escape through the openings at 38. The piston 11 is thus forced down in the cylinder until the shoulder 20 comes in contact with the knob on the end of the rod 22, which moves the slide-valve 23, and again admits steam into the cylinder *C* above the piston 30, and the action is repeated. The exhaust chambers at 36 and 38 communicate with the pipe 61, through which steam is exhausted. This pipe is indicated by 25 in Plate VI.

Fig. 380.



Question 653. *How is the air cylinder of the air pump constructed?*

Answer. It has air inlets at 48 and 51 and conical valves 45, 46, 49, and 50 above and below these inlets. When the piston 14 descends it compresses the air below it, which closes valve 50 and raises and opens 49, so that the compressed air passes into the chamber *D* and through the pipe 53—indicated by 7 in Plate VI—into the main reservoir. At the same time a partial vacuum is produced above the piston, which causes the atmospheric pressure below valve 46 to raise it, thus allowing air to flow into the cylinder through the air inlets at 48. The chamber above 45 is connected with the chamber *D* and main reservoir, so that when the pressure in them is greater than that below the valve 45, it is forced down on its seat and closed. The reverse action takes place when the piston 14 ascends—that is, valve 50 opens to admit air below the piston and 49 is closed by the pressure above it. At the same time 46 is closed and 45 opens, so that the air which is compressed above the piston flows through the valve 45 to the chamber *D*, and thence into the main reservoir.

Question 654. *How is the action of the air pump regulated?*

Answer. By means of what is called a pump governor, *F*, shown in fig. 380, on the left-hand side of the pipe connection at *A* and in a vertical section in fig. 381.

Question 655. *What is the construction and action of the pump governor?*

Answer. One end, 23, of the horizontal pipe 2 2 is connected to the boiler and the other end to the pump. The chamber 2 2 has a division and a valve, 9, between the two ends. The valve is connected by a stem, 7, to a piston, 5, which bears on a spiral spring, 8. 19 is a diaphragm which is pressed down by another spiral spring, 18, which resists a pressure under the diaphragm of about 70 lbs. per square inch. A small conical valve, 17, is connected to the diaphragm, and opens and closes an opening below it and above the piston 5. The space below the diaphragm is connected by a pipe, 21, to the brake-pipe. When the air pressure below the diaphragm exceeds 70 lbs. it raises it and opens the valve 17, which admits compressed air above the piston 5, which is forced down, thus closing the valve 9 and shutting off steam from the pump. The air in the pipe 21 then escapes past the piston 5, which fits loosely in its cylinder, and escapes from it into the open air, through an opening represented by dotted lines. When the pressure in the brake-pipe 21 is reduced the spring 18 closes the valve 17, so that the action of the spring 8 and the pressure below the valve 9 opens it and admits steam to the pump.

Question 656. *How are the brake-cylinders and pistons constructed?*

Answer. The construction of the brake-cylinders is shown in section by fig. 382. It is a simple cylinder with a piston, 8, which has leather packing, 9, and a piston-rod, 3. The piston-rod, after being driven out by compressed air, is forced back again by a spiral spring, 12, which is wound around the piston-rod.

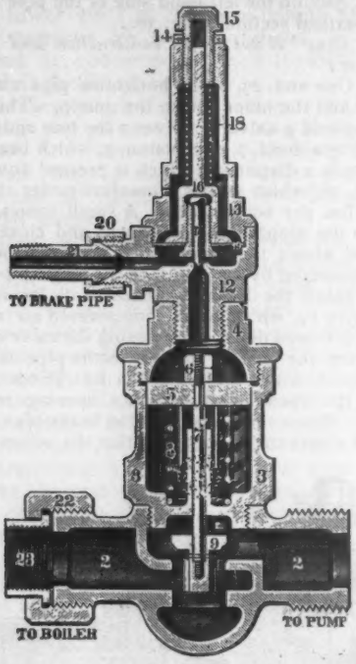


Fig. 381.

Fig. 383.

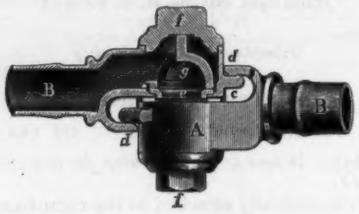


Fig. 384.

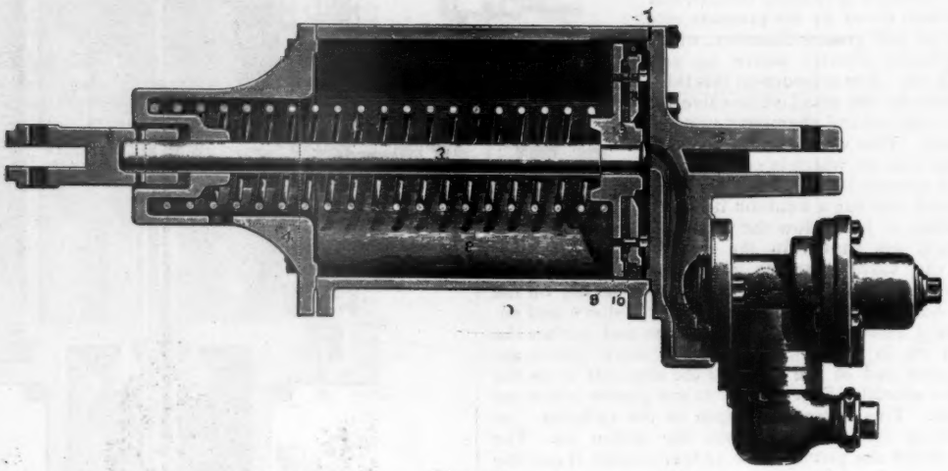


Fig. 382.

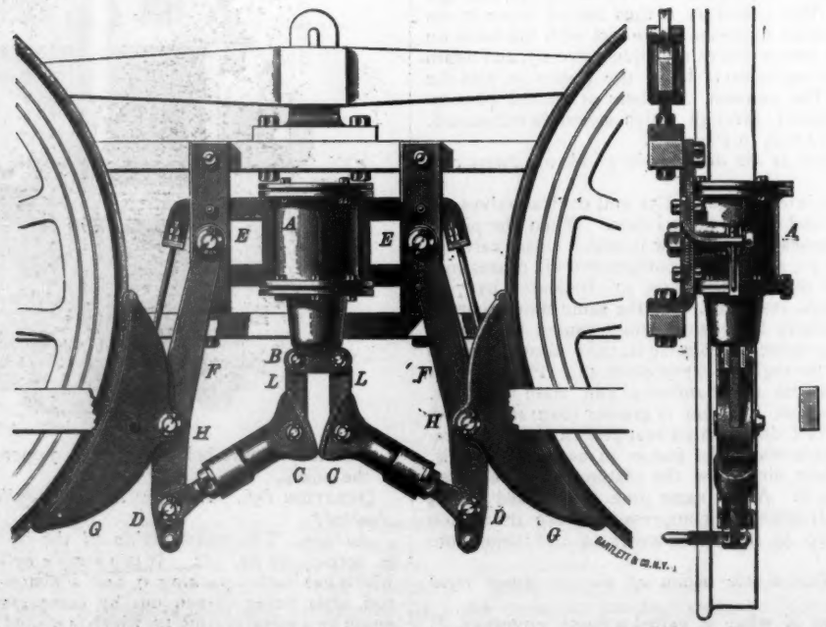


Fig. 385.

Fig. 386.

To prevent the application of the brakes from a slight reduction of pressure, caused by leakage in the brake-pipe, an oval groove—shown at *b* at the top of the piston in fig. 382—is cut in the body of the brake-cylinder, of such a length that the piston must travel three inches before the groove is covered by the packing leather. A small quantity of air, such as results from a leak, passing from the triple-valve into the cylinder, has the effect of moving the piston slightly forward, but not sufficiently to close the groove. This permits the air to flow out past the piston. If, however, the brakes are applied in the usual manner, the piston will be moved forward beyond the groove, notwithstanding the slight leak.

QUESTION 657. *How are the brake-pipes on the locomotive tender and cars connected together?*

Answer. By flexible hose, 5 5′ 5″, Plate VI, between the different vehicles in the train. The hose are attached at one end to the brake-pipes and are connected together between the different vehicles in the train by couplings, shown by figs. 383 and 384. Cocks 29 29′ 29″, Plate VI, are attached to the ends of the brake-pipes on each car and at the back end of the tender. The end of the pipe which comes at the end of the train can thus be closed to prevent the air in the brake-pipe from escaping.

QUESTION 658. *What arrangement is made for applying the brakes from the inside of the cars?*

Answer. A vertical pipe with a cock or valve, 28″, Plate VI—called a "conductor's valve"—on the upper end is connected to the brake-pipe on each car. By opening this valve the air in the brake-pipe can escape which applies the brakes. A cord which extends the whole length of the car is usually connected to this valve, so that it can be pulled from any part of the car.

QUESTION 659. *How is the moisture which condenses in the inside of the pipes and reservoirs removed?*

Answer. A cup called a drip-cup is connected to the brake-pipes below the tender, from which the water that collects in it is drawn by means of a cock in the bottom of the cup. Cocks are also attached to each reservoir, and when they are opened and if there is any water in the reservoirs it can escape.

QUESTION 660. *How are the air brakes on the locomotive arranged?*

Answer. The brake-shoes are usually applied to the driving-wheels, and are located between these wheels, as shown in Plate VI and fig. 385, which is a side view, and fig. 386 an end view, showing the arrangement of the brakes in relation to the wheels. A brake-cylinder, *A*, is placed on each side of the engine, the piston-rods of which work through the lower head. The rods have cross or T-heads, *B*, on their lower ends, which are connected by links, *L L*, to the cams *C C*. These cams are connected to the levers *F F* at *D D*. The levers have brake-blocks *G G* attached to them by pins at *H H*. The surfaces of the two cams which are in contact with each other are eccentric to the center of the pins *D D*, and when they are pressed down by the piston they force their lower ends *D D* and levers *F F* outward, which presses the brake-blocks against the wheels. 6, Plate VI, is the auxiliary reservoir for the engine or "*driver-brakes*," as they are called, and 12 is the triple-valve by which the brake on the engine is operated. 11 is the pipe which supplies the driver-brake reservoir with compressed air, and 10 is the pipe by which it is conveyed from the triple-valve to the brake-cylinders.

QUESTION 661. *What is meant by the term "Straight Air Brake?"*

Answer. As explained in answer to question 634, this term is used to designate the first form of the Westinghouse Air Brake, in which there were no auxiliary reservoirs under the cars, the compressed air being stored in a main reservoir on the engine or tender, from which it flowed direct through the brake-pipe to the brake-cylinders under the different vehicles. The brakes were released when communication was closed between the main reservoir and the brake-pipe, and opened from the brake-pipe to the atmosphere by means of the engineer's valve. When "straight air" is applied it flows direct through the brake-pipe to the brake-cylinders, and the auxiliary reservoirs, triple-valves, and pressure-retaining valves are not used, and the brake has no automatic action.

QUESTION 662. *How can the Automatic Brake be used as a Straight Air Brake?*

Answer. The old form of Automatic Brake can be converted into a Straight Air Brake by simply turning the handle *K*, fig. 369, of the four-way cock on the triple-valve downward to *M*, so as to stand in a vertical (|) position; the cock then opens direct communication from the brake-pipe to the brake-cylinders through the channels *a e d*. With the new quick-acting triple-valve, which will be described further on, the Automatic Brake cannot be converted into a Straight Air Brake.

QUESTION 663. *When should the Automatic Brake be used as a Straight Air Brake?*

Answer. In case of serious leakage of pipes, or other defect which prevents the use of the automatic brake, the handle of the four-way cocks of all the triple-valves, excepting those on vehicles on which the brakes are cut out, should be turned downward, and the train can then be run with "straight air" to the terminus. It is better to do this than to depend upon the use of the hand brakes; but all the brakes which are in use (that is, that are not cut out) on a train must be operated either by "straight air" or automatically, as the two systems will not work together on the same train.

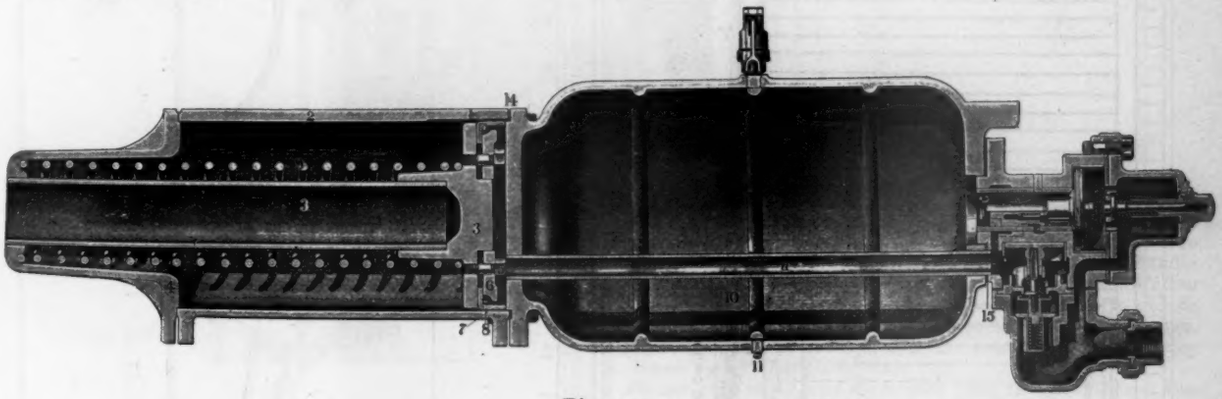


Fig. 391.

QUESTION 664. *How do the air brakes for freight trains operate, and how are they constructed?*

Answer. The action of brakes on freight trains is the same as on passenger trains, although the form of construction is somewhat different. Fig. 387 is a side elevation, and fig. 388 an inverted plan of a freight car with brake attached, and fig. 391 is a section of the cylinder and auxiliary reservoir. The construction of the cylinder is substantially the same as that used on passenger trains. The auxiliary reservoir is, however, made of cast iron, and is attached to the brake-cylinder head, as shown in fig. 391.

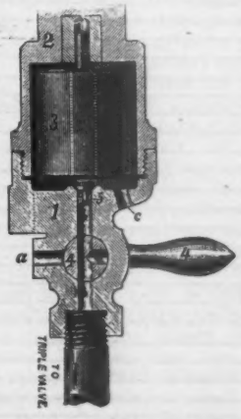
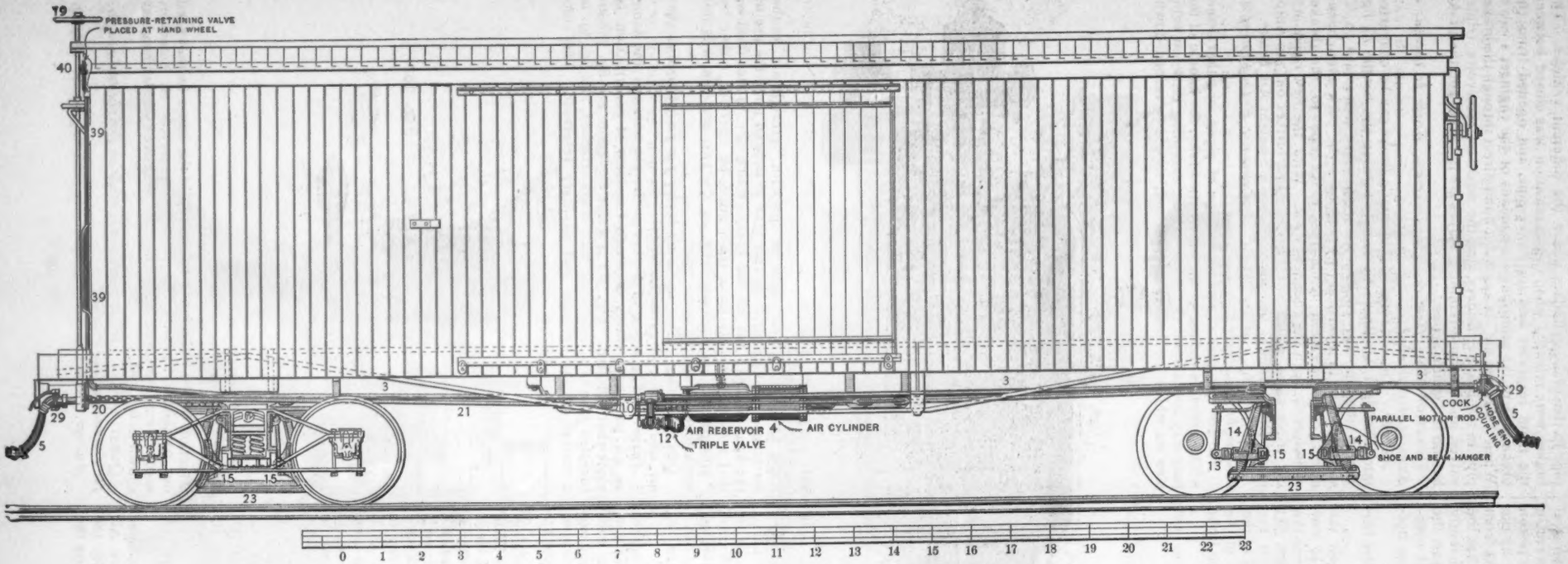


Fig. 392.

QUESTION 665. *What provision is made on freight train brakes for descending long grades?*

Answer. What is called a "*pressure-retaining valve*," 40, fig.

Fig. 387.


PRESSURE-RETAINING VALVE PLACED AT HAND WHEEL
AIR RESERVOIR
AIR CYLINDER
TRIPLE VALVE
PARALLEL MOTION ROD
SHOE AND BEAM HANGER
COCK
HOSE END COUPLING
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

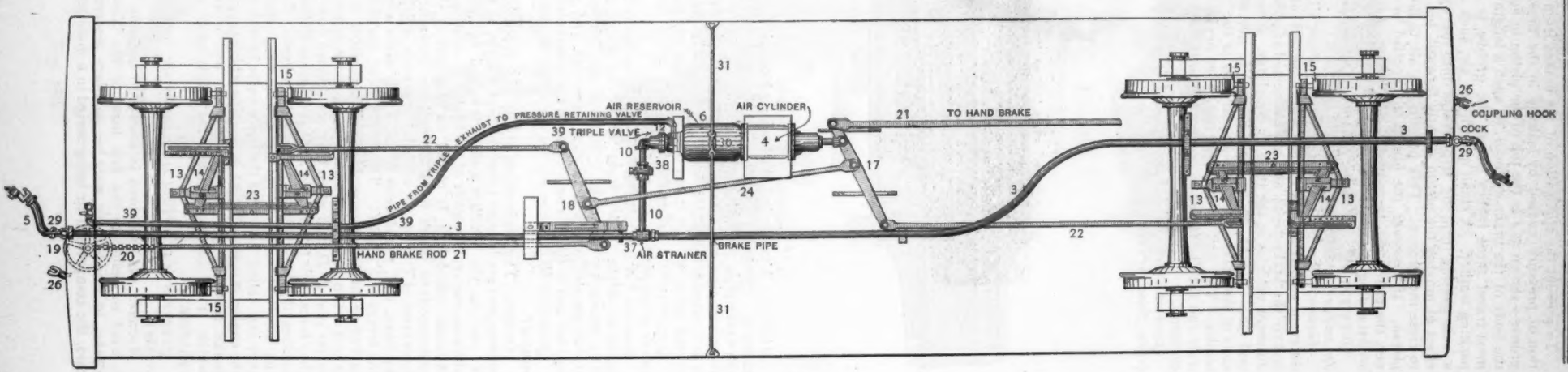


Fig. 388.

Fig. 394.

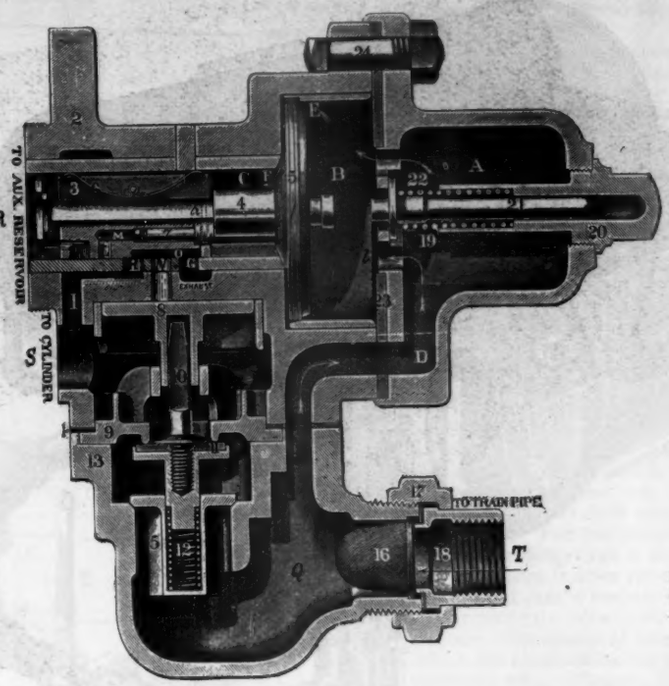


Fig. 393.

Fig. 395.

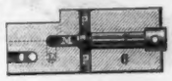


Fig. 396.

Fig. 397.

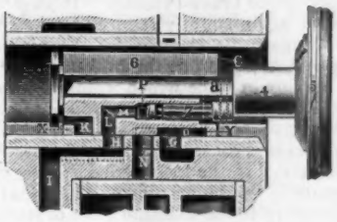


Fig. 398.

Fig. 399.

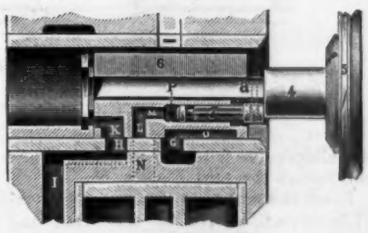
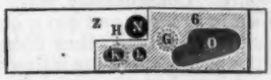


Fig. 400.



387, is connected by a pipe, 39 39, with the discharge port of the triple-valve 12. An enlarged section of this valve is shown by fig. 392. 5 is the valve which opens and closes the passage or pipe *b b*. The valve has a weight, 3, which presses it down. A pressure of about 15 lbs. in the pipe *b b* is sufficient to raise this weight and allow the air to escape at the opening *c*. 4 4 is a three-way cock which, in the position shown—with the handle horizontal—closes the opening *a*, so that the air can escape only under the valve 5 and opening *c*. As the valve is weighted no air can escape until its pressure is sufficient to raise the weight 3. Consequently, if the handle of the cock is turned to a horizontal position in descending long grades, a pressure of about 15 lbs. is retained in the brake-cylinder, which keeps the train under control when otherwise the brakes would be released to recharge the reservoirs. On slight grades or a level the handle of the cock should be turned down, which opens communication between the pipe *b* and opening *a*, which allows the air to escape freely from the discharge port *a* of the pressure-retaining valve.

QUESTION 666. *What difficulty was encountered in operating air brakes on long freight trains?*

Answer. In some tests made with long freight trains it was found that the triple-valve, which has been described, in answer to question 643, would not apply the brakes as quickly as was considered desirable. For that reason the quick-acting triple-valve represented in section by fig. 393 was designed by Mr. Westinghouse.

QUESTION 667. *How is this valve constructed and how does it act?*

*Answer.** The outside shell or casing of this valve has three openings, *R*, *S*, and *T*. *R* is connected to the auxiliary reservoir, *S* to the brake-cylinder, and *T* to the brake-pipe. The latter branch communicates by means of the passages *Q D D'* and openings *l l* with a cylinder, *B*, in which the triple-valve piston 5 works. The chamber *C* on the opposite side of this piston contains a slide-valve, 6, and is in direct connection with the auxiliary reservoir through the branch *R*, and when the piston is in the position shown in the engraving, compressed air from the train-pipe *T* can flow through the channels *Q D D' l* and through a groove *E* in the cylinder past the piston 5 until the pressure in *C* and in the auxiliary reservoir is equal to that in the train-pipe. At the same time the branch *S* and the brake-cylinder are connected to the atmosphere through the passage *I*, the port *H*, the cavity *O*, in the slide-valve 6, and the port *G* which emerges into the open air. If now the pressure in the train-pipe is slightly reduced by opening the engineer's valve, the pressure in the cylinder *B* will also be reduced, and the piston 5 will be moved to the right, as shown in fig. 397,† by the expansion of the air in the auxiliary reservoir. Under ordinary circumstances, however, the piston will be moved through only half of its available travel, in consequence of the pressure in the reservoir being reduced to that in the train-pipe by a part of the air flowing into the brake-cylinder in the following way: The stem 4 of the piston passes through the slide-valve 6—the connection between the two being so made that the piston can move a small distance without moving the valve. The slide-valve contains a small conical valve, 7, called a "graduating valve," which is seated in a cavity in the valve, and is shown in figs. 393, 397, and also in the

* Much of the following description was taken from one which originally appeared in *Engineering*.

† In drawing the sections of the valve and its seat, some liberty has been exercised in order to show how the valve acts. The sections are not strictly correct, but they thus show the operation of the valve more plainly than they would if they represented the valve exactly.

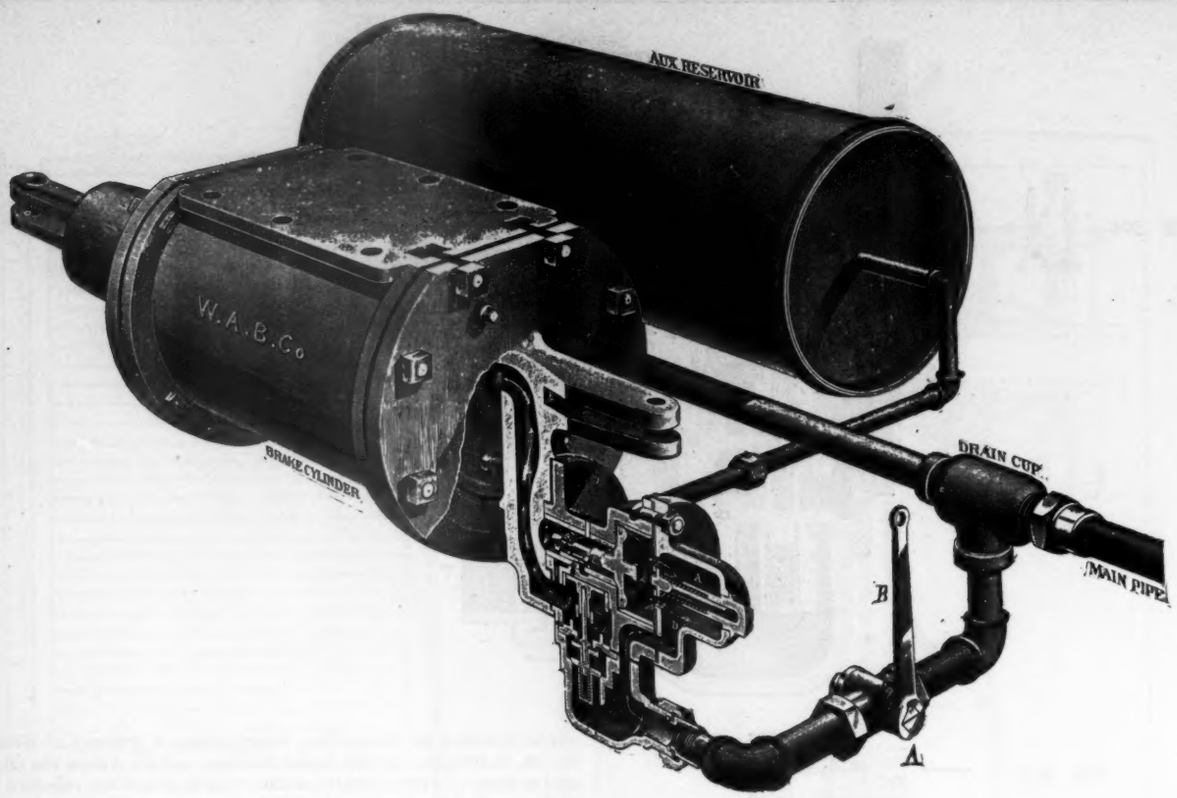


Fig. 401.

horizontal section, fig. 395, which is drawn through the center of the valve. This conical valve is connected to the slide-valve by a pin, *a*, so that when the piston first moves, it carries with it and opens the valve 7. This allows air which enters through the passages *P P* to flow into the passage *M*. The continued movement of the piston carries the slide-valve 6 to the right, as shown in fig. 397 and also in fig. 398, which represents a plan of the valve face with a horizontal section of the valve drawn on the line *X Y* of fig. 397. This movement of the valve first closes the connection of the port *H* with the atmosphere through the cavity *O*, and then brings the port *L* in the valve over the port *H* in the valve-seat. The air can then flow from the chamber *C* and auxiliary reservoir through the openings *P*, passage *M*, port *L*, port *H*, and passages *I* and *S* into the brake-cylinder, and it thus applies the brakes. As soon as the pressure in *C* has fallen slightly below that in the brake-pipe, the pressure on the opposite side *B* of the piston 5 moves the latter slightly back and closes the valve 7, and cuts off the air supply to the brake-cylinder. If now the pressure in the train-pipe be again slightly reduced by the engineer's valve, the valve 7 will again be opened by the piston 5, and in this way by repeated applications the brakes can be applied gradually up to the maximum force which would be possible when the pressure is equalized in the cylinders and auxiliary reservoirs.

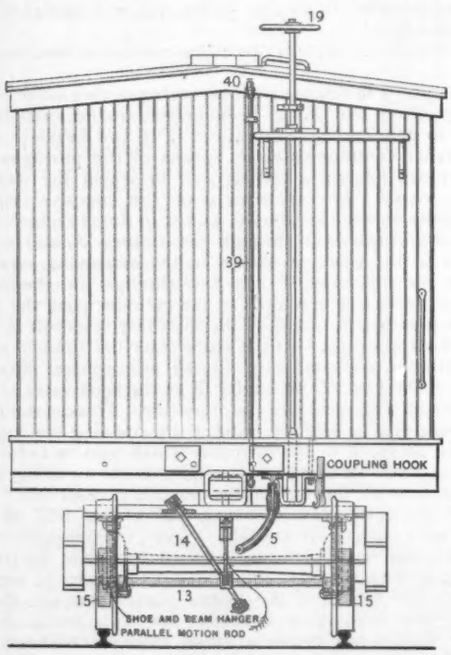


Fig. 389.

QUESTION 668. *How does the triple-valve, shown in fig.* 393, *act in making an emergency stop in case of danger?*

Answer. If the locomotive runner opens his valve wide the pressure in the brake-pipe will be so far reduced that the piston 5 will move to the extreme limit of its travel, and will seat itself against the leather ring 23. This opens the valve 7 and moves the slide-valve 6 to the position shown in fig. 399 and fig. 400, and brings the port *K* over *H*.

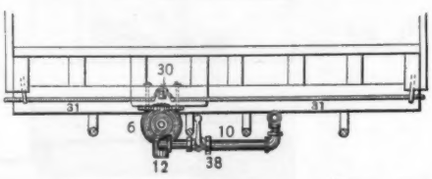


Fig. 390.

From the end view, fig. 394, and sectional plan, fig. 400, of the slide-valve 6, it will be seen that one corner of it at *Z* is cut away diagonally. Consequently, when the valve gets into the position shown in figs. 399 and 400 it uncovers the port *N*. Air from the auxiliary reservoir then flows through the passage *N* and acts on the piston 8, forcing it down, which opens the valve 11, fig. 393. As soon as this occurs the pressure in the chamber *Q* and train-pipe *T*, below the check-valve 15, raises it, and there is then a clear passage from the train-pipe through the pipe *S* into the brake-cylinder. There is also a passage from the auxiliary reservoir through the port *K*, fig. 399, and passage *I* into the brake-cylinder, but as the area of the cross sections of these passages, compared with that through the valves 11 and 15, is relatively small, the air in the train-pipe has time to discharge into the brake-cylinder before the pressure in the latter has been increased much by that which enters from the reservoir through *K* and *I*. The air in the brake-pipe has thus time to discharge into the cylinder and thus relieve the pressure in

Fig. 402.

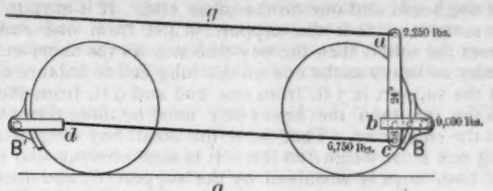


Fig. 403.

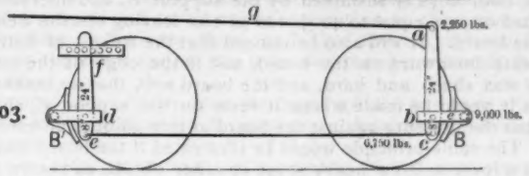


Fig. 404.

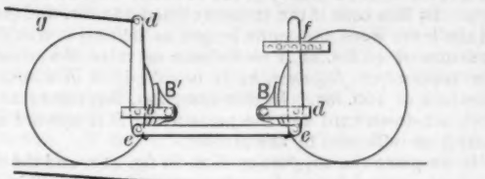
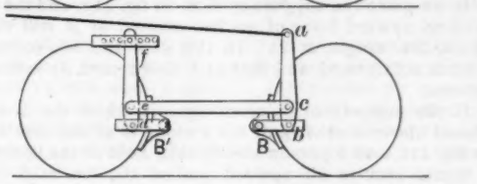


Fig. 405.



the pipe *before* the air from the auxiliary reservoir has increased the pressure above the check-valve 15 sufficiently to close it, thus preventing the air above it from flowing back into the brake-pipe. By this means the air in the brake-pipe under each vehicle is discharged into the brake-cylinder, thus utilizing it for applying the brakes and effecting a quicker discharge and more prompt application of the brakes than is possible if the air in the brake-pipe must all escape through the engineer's valve.

After the engineer has accomplished his object, the brakes are released in the usual way, by opening communication between the main reservoir and the brake-pipe through the engineer's valve on the engine. The pressure in the train-pipe *T* then flows through the passages *Q D l l* and moves the piston 5 back into the position shown in fig. 393. The cavity *O* in the valve then connects the passage *N* with the atmosphere, which relieves the pressure above the piston 8, which is raised by the pressure under it, and the valve 11 is closed by the spring 12 below it. The air in the brake-cylinder then exhausts through the passage *I*, port *H*, cavity *O* in the valve and passage *G* into the open air, and the springs in the brake-cylinder return the brake-pistons and take off the brake-blocks from the wheels, and the auxiliary reservoirs are again recharged through the groove *E*.

QUESTION 669. *How is the quick-acting triple-valve applied to the brake-cylinders?*

Answer. On passenger trains it is attached to the end of the brake-cylinder as shown in fig. 401, which is a perspective view of a brake-cylinder, auxiliary reservoir, and triple-valve—the latter shown in section—with their connections. On freight trains the auxiliary reservoir is attached to the brake-cylinder head, and the triple-valve is bolted to the end of the reservoir with a pipe, *a*, running through the latter, as shown in fig. 391, which represents a section of these parts.

QUESTION 670. *With how much force should the brake-blocks be pressed against the wheels?*

Answer. The friction between the brake-blocks and the wheels, and between the wheels and the rails, or the "adhesion" of the wheels, is very nearly the same with equal pressures. Therefore, if the force with which the brakes are pressed against any of the wheels should be greater than the weight on the rails under those wheels, the friction of the brake-blocks would exceed the adhesion of the wheels to the rails, and the wheels would slide. For this reason the pressure of the brakes on any pair of wheels should never exceed the weight on the rails under those wheels. Experience has shown that the wheels of passenger cars are liable to slide if the brake pressure on any of the wheels exceeds 90 per cent. of the weight on the rails under them, and if they do slide they are liable to have flat spots worn on the treads. For this reason the pressure of the brake on any wheel of a passenger car is limited to 90 per cent. of the weight on the rail under it when the car is empty or light, and the pressure on freight cars is limited to 70 per cent. of the light weight.

QUESTION 671. *How is the pressure applied to the brake-shoes?*

Answer. By means of levers connected to the brake-beams to which the brake-shoes are attached.

QUESTION 672. *How are the brake-levers arranged in relation to the wheels?*

Answer. The levers which are connected to the brake-beams are arranged in several different ways. Fig. 402 shows the simplest arrangement in use for hand-brakes, with the brake-blocks *B B* outside of the wheels. It consists of a single lever, *a b c*, which is connected to the brake-beam *e* by a fulcrum, *b*. The lower end *c* of the lever is connected by a rod, *c d*, to the brake-beam *d*. The upper end *a* of the lever is connected by a rod, *g*, to the brake-windlass. This arrangement is open to the objection that the pressure on the brake-beam *B* is greater than that on *B'*, and therefore this plan is now seldom used.

Fig. 403 represents an arrangement with double levers which are attached to the brake-beams in the same way as the lever *a b c* shown in fig. 402. The brake-blocks are also outside of the wheels, and the lower ends of the levers are connected together by a rod, *c e*. The upper end of the lever *e d f* is held by an adjustable stop at *f*. With this arrangement, the rod *c e* is in tension when the brakes are applied by the brake-windlass.

Fig. 404 represents an arrangement with two levers and the brake-blocks *B B'* between the wheels. The upper end *a* of the lever *a b c* is connected to the brake-windlass, and *f d e* is held by an adjustable stop *f*. The rod *c e* is in compression when the brakes are applied.

Fig. 405 shows another arrangement similar to fig. 404, excepting that the rod *c e* is above instead of below the brake-beams.

STEVENS SYSTEM.

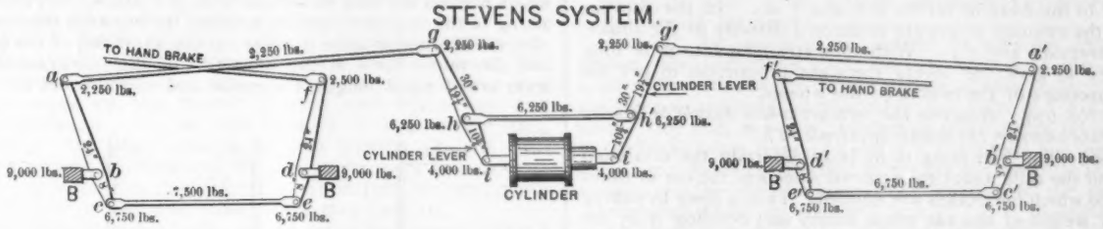


Fig. 406.

HODGE SYSTEM.

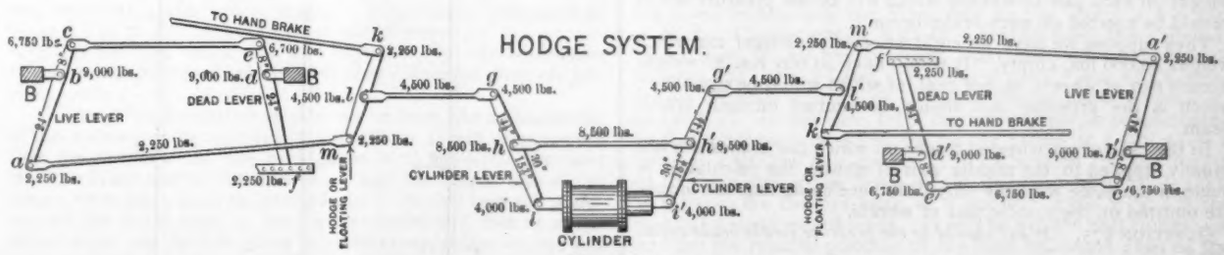


Fig. 407.

QUESTION 673. *How are the air brake cylinders connected to the brake-levers?*

Answer. Two systems, the Stevens and the Hodge, shown by figs. 406 and 407, are used. The brake cylinders are usually placed between the two trucks and have two levers, $g\,i$ and $g'\,i'$: one of these, $g'\,i'$, is connected to the brake-piston at i', and the other, $g\,i$, to the brake-cylinder at i. They are connected together by a tie-rod, $h\,h'$, and in the Hodge brake by rods $g\,l$ and $g'\,l'$ to the floating levers $k\,m$ and $k'\,m'$. In the Stevens system the cylinder levers are connected directly to the brake-beam levers $a\,c$ and $a'\,c'$. With this arrangement, it is only necessary to give the levers the right proportion to get the proper pressure of the brakes on the wheels.

Fig. 408.

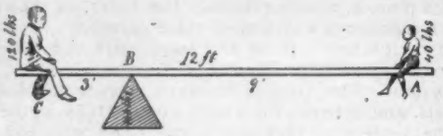


Fig. 409.

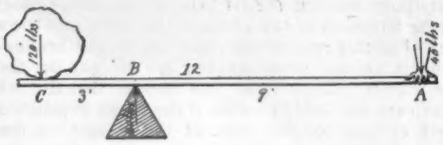


Fig. 410.

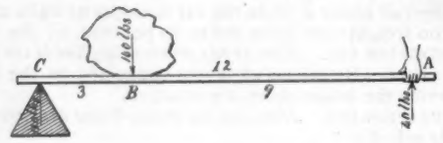
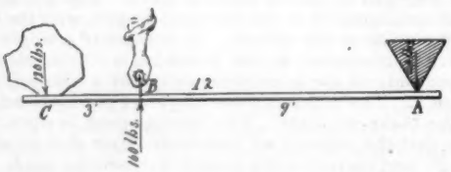


Fig. 411.



QUESTION 674. *How can the pressure which should be exerted by the brake-shoes on the wheels be calculated?*

Answer. The first thing to do is to ascertain the minimum weight on the rails under each pair of wheels of the car or other vehicle to which the brakes are applied. This is done by taking the total weight of the car when empty and dividing it by the number of its pairs of wheels. Then for passenger cars take 90 per cent. and in the case of freight cars 70 per cent. of the weight on each pair of wheels, which will be the pressure which should be exerted on each brake-beam.

Thus suppose we have an eight-wheeled passenger car which weighs 40,000 lbs. empty. It would have 10,000 lbs. of weight to each pair of wheels, 90 per cent. of which would be 9,000 lbs., which is the pressure that should be exerted on each brake-beam.

In the case of six-wheeled trucks on which the brakes are not usually applied to the middle pair of wheels, the calculation is made in the same way, the only difference being that the brakes are omitted on the middle pair of wheels.

QUESTION 675. *What should be the pressure in the brake-cylinders?*

Answer. Experience has shown that a pressure of 50 lbs. per square inch in the cylinders of the old automatic and 60 lbs. with the new quick-acting brake is the best that can be used. The size of the cylinders and the brake-levers should then be so proportioned that this air pressure will exert the required force on the brake-beams.

QUESTION 676. *How can the proportion of the brake-levers be calculated?*

Answer. Their proportions are calculated from the well-known principle of the lever.

QUESTION 677. *How may the principle of the lever be explained?*

Answer. Every boy has learned that if the middle of a board rests on a fence-rail or other support that two boys, of equal weight, will balance each other, if one of them sits on one end of the board and one on the other end. If it is 12 ft. long, and is moved so that the support is 4 ft. from one end and 8 ft. from the other, then the boy who sits on the short end must be twice as heavy as the one on the long end to balance each other. If the support is 3 ft. from one end and 9 ft. from the other, as in fig. 408, then the heavy boy must be three times the weight of the small one. That is, if the small boy weighs 40 lbs. the big one must weigh 120 lbs. It is also obvious that the weight of both boys is sustained by the support B, and therefore the load on it is equal to $40 + 120 = 160$, leaving out the weight of the board. It will also be noticed that the weight of both boys bears downward on the board, and if the edge of the support B was sharp and hard, and the board soft, that an indentation in it would be made where it rests on the support C, showing that the pressure against the board at this point is upward.

The same principle would be illustrated if the board was used as a lever to lift a heavy stone or other object, as shown in fig. 409. In this case if the stone weighed 120 lbs. and the two arms of the lever were the same length as before, it would require a pressure of 40 lbs. at A to balance or raise the stone at C, and the support or *fulcrum*, as it is called, at B would sustain a pressure of 160 lbs. In this case, too, the forces at A and C' both act downward and the pressure of B is upward against the board, as indicated by the arrows.

If we place the support at C, as in fig. 410, and the stone at B, then an upward force of 40 lbs. exerted at A will raise a stone of 160 lbs. weight at B. In this case the two forces at A and C both act upward, and that at B downward, as indicated by the arrows.

If the support or fulcrum against which the board bears is placed above it at A, and if the stone is at the end C, as shown in fig. 411, and a person should take hold of the board at B, then it would require an upward pull of 160 lbs. at B to raise the stone, and the forces would act in the direction indicated by the arrows.

From these illustrations it will be seen that in each case when the levers are in equilibrium or are balanced, *there are two forces which act in one direction against the ends of the lever, and one force which acts in the opposite direction between them*, and that *the two end forces added together or their sum is equal to the third force acting in the opposite direction.* This is true not only of the cases illustrated, but it is true *of all levers* on which the forces act in directions parallel to each other, which are the only kind which need be considered here. The greater of the two forces which act in the same direction on the short end of the lever will be called the *major-force*, the smaller one, which acts on the long end of the lever, the *minor-force*, and that acting in the opposite direction between the two ends the *counter-force.* The major-force is always at the short end of the lever, and the minor-force at the long end. If the two arms of the lever are of equal length, the major and minor-forces will also

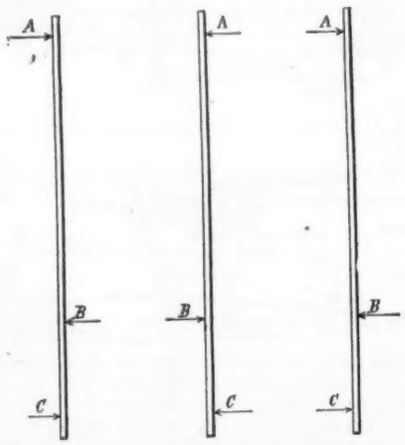


Fig. 412. Fig. 413. Fig. 414.

be equal. If *the major-force is multiplied by the length of the short arm of the lever, the product will always be equal to that of the minor-force multiplied by the length of the long end of the lever.* That is, in fig. 408 the weight of the major boy, $C = 120$ lbs., multiplied by 3 ft., the length of the short end $C\,B$, $= 360$, and the weight of the minor boy, $A = 40$ lbs. $\times$ 9 ft., the length of the long end $A\,B = 360$.

It does not make any difference either in what direction these forces act. The effect of the in-action will be the same, if instead of being horizontal the levers stood upright or vertical, as shown in figs. 412–414, in which the direction of the

forces is indicated by darts and their magnitude by figures. These figures show, too, that the action of the forces in figs. 412 and 414 is exactly the same, and that the only difference between them and fig. 413 is that the forces in the two cases act in opposite directions.

QUESTION 678. *How can we know which is the major, which the minor, and which the counter force acting on a lever?*

Answer. This can always be known with certainty if it is remembered that the major and minor-forces always act on the ends of the lever and in an opposite direction to the counter-force* which is between them, and that the major-force is always at the short end of the lever and the minor one at the long end.

QUESTION 679. *If we have the length of the two ends of a lever and either the major or the minor-force, how can we calculate the other?*

Answer. MULTIPLY THE KNOWN FORCE BY THE LENGTH OF ITS END OF THE LEVER AND DIVIDE THE PRODUCT BY THE LENGTH OF THE OPPOSITE END. The quotient will be the required force. Thus: supposing that in fig. 408 we have the weight of the small boy, 40 lbs., and the length of the two ends of the lever as 9 and 3 ft. respectively, then $40 \times 9 \div 3 = 120$ = the major-force *C*.

QUESTION 680. *If we have the length of the two ends of a lever and either the major or the minor-force, how can we calculate the counter-force?*

Answer. ADD THE LENGTH OF THE TWO ENDS OF THE LEVER TOGETHER TO GET ITS WHOLE LENGTH; THEN MULTIPLY THE KNOWN FORCE BY THE WHOLE LENGTH AND DIVIDE BY THE OPPOSITE END OF THE LEVER. Thus in fig. 408, knowing the weight of the small boy at *A*, and the length of the two ends of the lever being 3 and 9 ft., then $3 + 9 = 12 \times 40 \div = 160 =$ counter-force at *B*.

QUESTION 681. *If we have the counter-force and the length of the two ends of the lever, how can we calculate the major and minor-forces?*

Answer. TO GET THE MAJOR-FORCE, MULTIPLY THE COUNTER-FORCE BY THE LENGTH OF THE LONG END OF THE LEVER AND DIVIDE BY ITS WHOLE LENGTH; TO GET THE MINOR-FORCE, MULTIPLY THE COUNTER-FORCE BY THE LENGTH OF THE SHORT END OF THE LEVER AND DIVIDE BY ITS WHOLE LENGTH. Thus if in fig. 409 we have *B*, the counter-force equal to 160 lbs., and the two arms of the lever 3 and 9 ft. respectively, then $160 \times 9 \div 12 = 120 =$ major-force, or $160 \times 3 \div 12 = 40 =$ minor-force.

QUESTION 682. *Having the major and minor-forces which are exerted at the ends of a lever, and its whole length, how can we calculate the length of its two ends?*

Answer. FIRST ADD THE MAJOR AND MINOR-FORCES TOGETHER, WHICH WILL GIVE THE COUNTER FORCE; THEN TO GET THE LENGTH OF THE LONG END OF THE LEVER MULTIPLY THE MAJOR-FORCE BY THE WHOLE LENGTH AND DIVIDE BY THE COUNTER-FORCE. TO GET THE LENGTH OF THE SHORT END, MULTIPLY THE MINOR-FORCE BY THE WHOLE LENGTH AND DIVIDE BY THE COUNTER-FORCE. OR IF WE HAVE THE LENGTH OF ONE END WE CAN GET THAT OF THE OTHER BY DEDUCTING THE LENGTH OF THE ONE FROM THE WHOLE LENGTH.

Thus supposing that in fig. 409 the major and minor-forces *A* and *C* are equal to 120 and 40 lbs. respectively, and the whole length of the lever 12 ft., then $120 + 40 = 160 =$ counter-force, and $120 \times 12 \div 160 = 9 =$ length of long end of lever, and $40 \times 12 \div 160 = 3 =$ length of short end of lever.

QUESTION 683. *How can the proportions of the brake-beam levers and the pressures exerted by them be calculated from the preceding rules?*

Answer. To illustrate how this can be done, the arrangement of lever shown in fig. 402 will be taken first. It will be supposed that the pressure on the brake-shoe is to be 9,000 lbs., and that the lower end of the lever is 8 and the upper one 24 in. long; what force must be exerted at *a*? In this case the pressure on the brake-shoe is the counter-force, and that at *a* the minor-force; by the rule given in answer to question 681, we will have $9,000 \times 8 \div 32 = 2,250$ lbs. = the force which must be exerted at *a*. To get the major-force exerted at *c* on the rod *c d* and brake-shoe *B'* we have $9,000 \times 24 \div 32 = 6,750$. This explains what has already been pointed out, that with this arrangement of brakes the pressure on the shoe *B'* is less than that on *B*.

If we want to calculate the pressure which a force at *a* of 2,250 lbs. would exert on the brake-shoe, by the rule in answer to question 680, we will have $24 + 8 = 32 \times 2,250 \div 8 = 9,000 =$ pressure on *B*.

The calculations are similar for the leverages in figs. 403, 404 and 405. In fig. 403, with a force of 2,250 lbs. at *a* we would again have 9 000 at *b* and 6,750 at *c*, and as this is exerted on the rod *c e*, it would be the major-force acting on the lever *f d e*. To get the pressure exerted on the brake-shoe *B'* by the rule, in answer to question 680, we would have $8 + 24 = 32 \times 6,750 \div 24 = 9,000$ lbs., showing that with this arrangement of levers the pressure on the two brake-shoes is equal.

It happens in applying air-brakes to cars that the proportions of the brake-beam levers *a b c* and *f d e*, figs. 406 and 407, are nearly always established; therefore the problem usually is to proportion the cylinder-levers *g h i* and *g' h' i'* to produce a given pressure on the brake-beams with some given dimensions of brake-beam levers.

QUESTION 684. *How are the proportions of the cylinder-levers calculated?*

Answer. As an example, we will take the dimensions and pressures referred to in the answer to the previous question, and represented in fig. 403. With the proportions of levers given to exert a force of 9,000 lbs. on the brake-beams, there must be a pull of 2,250 lbs. on the rods *a g* and *a' g'*, fig. 406. These rods are connected to the cylinder-levers *g h i* and *g' h' i'*. One of these levers is connected to the cylinder at *i* and the other to the piston-rod at *i'*, and they are connected together by the rod *h h'*. Consequently, when the piston-rod is forced out it exerts a pull on the rods *h h'*, *g a*, and *g' a'*, which is communicated to the levers *a b c* and *a' b' c'*. If the cylinder is 10 in. in diameter—a usual size—the area of its piston will be 78.5 square in., which multiplied by a pressure of 50 lbs. per square in. will give a total pressure on the piston of 3,925 lbs., which for even figures will be taken at 4,000 lbs. The total length of the cylinder-levers *g h i* and *g' h' i'* will be assumed to be 30 in., and it has been shown that a pull of 2,250 lbs. is required on the rods *a g* and *g' a'* to produce the required pressure on the brake-beams. The problem then is to determine the length of the two ends of the cylinder-levers so that a pressure of 4,000 lbs. exerted by the piston at *i'* will pull with a force of 2,250 lbs. at *g* and *g'*. We have the major and the minor-forces and the total length of the lever, so that by the rule in answer to question 682 we would have $2,250 + 4,000 = 6,250 =$ the counter-force at *h* and *h'*. $4,000 \times 30 \div 6,250 = 19.2$ in. = long end of lever. The length of the short end of the lever is, of course, equal to its whole length less the length of the long end, or $30 - 19\ 2 = 10.8$ in.

Some care should be taken not to get the position of the ends of these levers reversed from what they should be. *The short end should always be next to the major-force and the long end next to the minor-force.*

QUESTION 685. *What different arrangement of levers is used in applying the air-brake?*

Answer. As explained in answer to question 673. Two systems are commonly used, the one known as the Stevens system, fig. 406, and the Hodge system, shown in fig. 407. In the latter what are called floating-levers, *k l m* and *k' l' m'*, are used. One end, *m* and *m'*, of each of these levers is connected to the brake-beam lever *a b c* and *a' b' c'* by rods *m a* and *m' a'*; the other ends of the floating-levers are connected to the hand-brakes, and the cylinder-levers are connected to the middle of the floating-levers by rods *g l* and *g' l'*. It is obvious that with this arrangement, if the two ends of the floating-levers are of equal length, one-half of the pull which is exerted by the cylinder-levers, through the rods *g l* and *g' l'*, is transmitted to the hand-brakes, and the other half to the levers *a b c* and *a' b' c'*. Consequently, with this arrangement the cylinder-levers must be so proportioned that they will exert a pull through the rods *g l* and *g' l'* equal to double that which must act on the ends *a* and *a'* of the "live" brake-beam levers *a b c* and *a' b' c'*. In this case, then, the levers must be proportioned so that a pressure of 4,000 lbs. on the piston at *i* will exert a force of 4,500 lbs. at *g* and *g'*. The calculation for the length of the long end of the lever would therefore be $4,500 + 4,000 = 8,500 =$ the counter-force at *h* and *h'*. $4,500 \times 30 \div 8,500 = 15\frac{7}{8} =$ long end of lever. It will be noticed that in figs. 406 and 407 the relative position of the long and short ends of the cylinder-levers is reversed; in fig. 406 the short end is next to the cylinder, whereas in fig. 407 the long end is in that position.

The force exerted on the rod *h h'*, fig. 407, will be equal to the counter-force, or $4,000 + 4,500 = 8,500$ lbs. By calculating the effect of this, it will be found that the same force is exerted on the rods *g l* and *g' l'*, showing that the brakes are applied equally on both trucks.

QUESTION 686. *How may the rules for calculating the length of brake-levers be summarized?*

Answer. The following are the essential rules to be used for such calculations:

I. *To get the pressure on the brake-piston:* MULTIPLY THE AREA OF THE BRAKE-PISTON IN SQUARE INCHES BY THE AIR PRESSURE PER SQUARE INCH, IN LBS., IN THE CYLINDER (usually 50 lbs.).

II. *To get the pressure on each brake-beam:* FOR PASSENGER

* The direction in which a force acts on a lever can always be known by observing which side of the lever would be indented if it was made of soft material and the force was exerted against it by a sharp object.

CARS TAKE 90 PER CENT. OF THE WEIGHT (when empty), IN LBS., ON THE RAILS BELOW THE WHEELS TO WHICH THE BRAKES ARE APPLIED AND DIVIDE BY THE NUMBER OF BRAKE-BEAMS.

III. *To get the force which must be exerted at the upper end of each brake-beam lever:* If the brake-beam is attached to the lever between its two ends (as in fig. 404) MULTIPLY THE PRESSURE ON THE BEAM, IN LBS., BY THE LENGTH IN INCHES OF THE SHORT END OF THE LEVER, AND DIVIDE BY ITS WHOLE LENGTH. If the brake-beam is attached to the end of the lever (as in fig. 405) MULTIPLY THE PRESSURE ON IT, IN LBS., BY THE LENGTH IN INCHES OF THE SHORT END OF THE LEVER, AND DIVIDE BY THE LENGTH IN INCHES OF THE LONG END.

IV. *To get the proportions of the brake-cylinder levers:* If floating-levers are not used (as in fig. 406): TAKE THE FORCE, IN LBS., EXERTED AT THE TOP OF EACH LIVE BRAKE-BEAM LEVER; if floating-levers are used (as in fig. 407), TAKE DOUBLE THIS FORCE AND ADD IT TO THE PRESSURE, IN LBS., EXERTED ON THE BRAKE-PISTON. THEN TO GET THE LENGTH OF THE END OF THE LEVER NEXT TO THE CYLINDER, MULTIPLY ITS WHOLE LENGTH BY THE FORCE EXERTED, IN LBS., ON THE OPPOSITE END OF THE LEVER, AND DIVIDE THE PRODUCT BY THE SUM OF THE FORCES EXERTED AT THE TWO ENDS OF THE LEVER. The length of the other end of the lever could be obtained by multiplying its whole length by the pressure exerted on the piston and dividing by the sum of the forces as before.

QUESTION 687. *In what distance can trains be stopped at different speeds with a quick-acting automatic brake?*

Answer. This to some extent depends upon the number of wheels in the train to which the brakes are applied. If all the wheels in a train, excepting the truck wheels of the locomotive, have brakes, it can be stopped quicker than is possible if the driving-wheels have no brakes, or if the cars have six-wheeled trucks on which brakes are seldom applied to the middle pair of wheels. Under the most favorable conditions, with all the cars empty, trains can be stopped in about the following distances:

At	20	miles an hour,	120	ft.
"	30	" " "	270	"
"	40	" " "	480	"
"	50	" " "	750	"
"	60	" " "	1,080	"

If the cars are loaded, these distances would be increased in proportion to the loads.

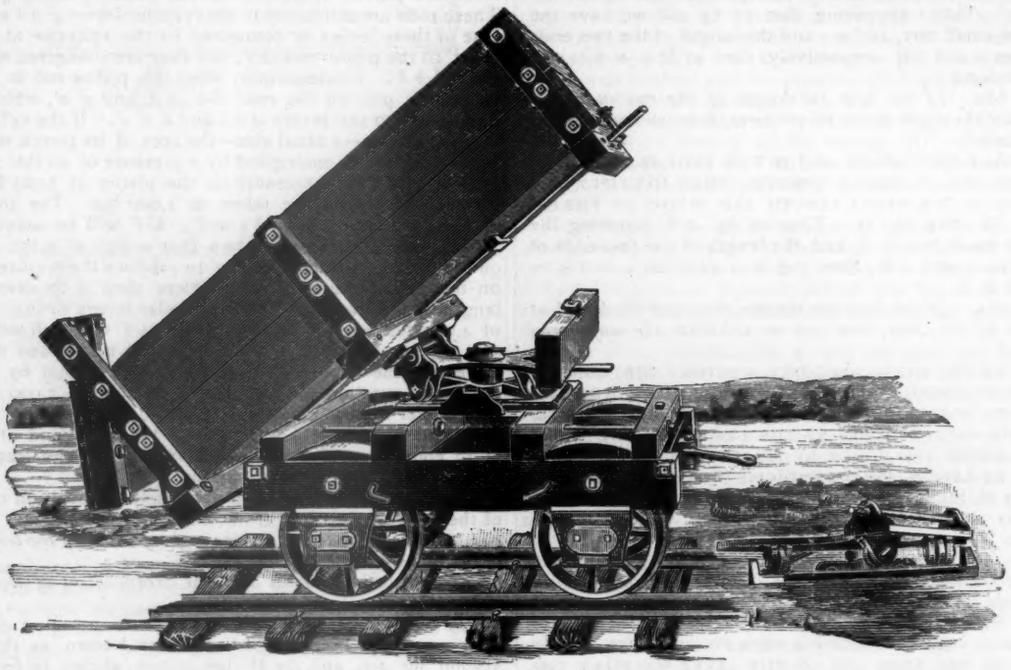
(TO BE CONTINUED.)

Manufactures.

A New Rotary Dumping Car.

THE accompanying illustration shows a new and very convenient pattern of dumping car for contractors' use and similar purposes. The car shown is of 30-in. gauge, and has a capacity of 1½ cubic yards of earth. It is carried on four 16-in. chilled wheels, with 2¼-in. axles and outside bearings. The frame is of 4 × 6 in. white oak, and is 50 in. long and 46½ in. wide. The body is of white oak 5 ft. long, 5 ft. wide and 16 in. deep. The wheel base is 30 in. and the total height above the rail only 47 in. The gate of the car swings outward, and the hinge is so arranged that the bolt is free from all bending strains.

The chief peculiarity of this car is in the turn-table, which is a new device of the manufacturers. This arrangement is very simple, consisting of two plates of cast iron, the total weight of which is 230 lbs. The bottom plate rests on the middle cross-sills of the frame and is 20 × 20 in. square, having cast from the center a hub 2½ in. diameter, which projects above the plate 6½ in., and two latch rests. The top casting contains four small rollers, a wrought-iron latch and dumping lugs, and revolves with the body of the car. The wrought-iron latch is 12½ in. long, and is held in position by a bolt and a guard. When the car is turned to dump on either side this latch drops automatically into the rests on the bottom casting, thus holding the car firm; when running, it prevents the car from turning or slewing in the least. It can be raised by the hand or foot when it is desired to revolve the car. The advantage of this arrangement is that the car will dump on both ends or sides. Its construction will be very readily understood from the engraving.



A NEW ROTARY DUMPING CAR.

This car is manufactured by Ryan & McDonald, of Waterloo, N. Y.; it is made all sizes, from 30 to 38 in. gauge and from 1½ to 2½ yards' capacity. These cars are used by contractors, in brick-yards and for similar purposes, and have given general satisfaction.

Bridges.

THE Hilton Bridge Company, Albany, N. Y., has just completed a double-track railroad bridge over the Erie Canal at Rome, N. Y., for the New York Central & Hudson River Road. This bridge is a through lattice bridge with two trusses, and is 90 ft. span. It is made of open-hearth steel, with all holes for the rivets drilled. The floor is of solid plate, carrying a track with gravel ballast; the roadway being the same as at any other point. The bridge was designed by Messrs. Walter Katte and George H. Thomson.

THE Smith Bridge Company, Toledo, O., recently completed a highway bridge over the Passaic River, at Avondale, having a draw span 165 ft. long and two fixed spans of 90 ft. each.

THE Phœnix Bridge Company is building a cantilever bridge over the Colorado River at Red Rock, Ari. The dimensions of this bridge are 990 ft. from center to center of anchorage; 660 ft. from center to center of main piers; the suspended span will be 330 ft. long, the cantilever arms 165 ft. each and the anchor arms 165 ft. each. The suspended span will have a depth of truss of 55 ft. and the cantilever will have a depth of truss of 101 ft. over the main piers.

Blast Furnaces of the United States.

THE *American Manufacturer* gives its usual monthly statement of the condition of the blast furnaces on March 1, which is thus summed up: "The totals are as follows:

	In Blast.		Out of Blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	59	11,568	109	12,412
Anthracite	100	33,383	97	24,162
Bituminous	152	97,783	74	36,548
Total	311	142,734	280	73,122

"The table shows a decrease of 15 furnaces in blast on March 1 as compared with the number in blast February 1. There has been a decrease of 7 in the number of charcoal, 4 in anthracite and an increase of 6 in the number of bituminous. The weekly capacity of the furnaces in blast has been increased from 134,815 tons to 142,734 tons, or 7,819 tons.

"The appended table shows the number of furnaces in blast on March 1, 1889, and on March 1, 1888, with their weekly capacity.

	March 1, 1889.		March 1, 1888.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	59	11,568	62	11,713
Anthracite	100	33,383	102	29,066
Bituminous	152	97,783	129	76,800
Total	311	142,734	293	117,579

"This table shows that the number of furnaces in blast, March 1, was 18 more than at the same date in 1888, the changes being distributed as follows: Charcoal, decrease, 3; anthracite, decrease, 2; bituminous, increase, 23. The weekly capacity of the furnaces blowing was 142,734 tons; at the corresponding date last year, 117,579, an increase of 25,145 tons, with 18 more furnaces in blast."

Coal Production in 1888.

COAL production in the United States in 1888, as compared with 1887, is estimated by the Statistical Bureau of the Geological Survey as follows, in tons of 2,000 lbs.:

	1888.	1887.
Anthracite	43,578,000	39,506,255
Bituminous	94,937,700	84,509,000
Total	138,515,700	124,015,255

Pennsylvania was the largest bituminous producer, with 32,500,000 tons. Ohio reported last year 11,950,000 tons, Illinois 11,855,200, and West Virginia 5,498,800; no other State produced over 5,000,000 tons. Coal was mined in 30 States and Territories.

The above estimate does not include coal consumed at mines, which is estimated at 6,848,000 tons, making a total of 145,363,000 tons taken out last year.

Cars.

THE South Baltimore Car Works are building 50 Eastman heater cars for the Baltimore & Ohio, and have taken a contract for 650 box cars for the Richmond & Danville Railroad.

THE Baltimore & Ohio Company has contracted for 150 box, 300 flat, 6 postal, 4 baggage, and 26 passenger cars to be furnished by the Finance Company, of Pennsylvania, under a car trust agreement.

THE Middletown Car Works, Middletown, Pa., is building 350 box cars for the Philadelphia & Reading Road.

THE Harrisburg Car Manufacturing Company is building 150 box cars for the New Jersey Central.

THE Seaboard & Roanoke Railroad has just completed 100 box cars at its shops at Portsmouth, Va.

THE Muskegon Car Company, Muskegon, Mich., is building a number of Zimmerman refrigerator cars to be used in carrying beer to Texas.

THE Safety Car Heating & Lighting Company, New York, is supplying its heating apparatus to the New Jersey Central and the Kansas City, Fort Scott & Gulf Roads. It is supplying its heating system to the sleeping cars of the Wagner Company.

AT the last annual meeting of the Jackson & Woodin Manufacturing Company, at Berwick, Pa., the following officers were elected: President, C. R. Woodin; Vice-President and General Manager, C. H. Zehnder; Secretary, Frederick H. Eaton; Treasurer, Garrick Mallery. Mr. H. F. Glenn was appointed General Superintendent. This Company is now making a specialty of castings for elevated roads and street railroad structures, and is filling contracts for such work for the Union Elevated Railroad, Brooklyn, N. Y., and for the electric railroad now under construction on the Bentley-Knight System, in Fulton Street, New York. In the car department the Company is completing 250 box cars for the Delaware & Hudson Canal Company, and has just finished some coal cars for the Union Elevated Road.

Locomotives.

THE Schenectady Locomotive Works, Schenectady, N. Y., have recently completed 8 twelve-wheel locomotives for the Central Pacific, and 7 mogul engines for the Duluth & Iron Range. The works are building a number of engines for the Charleston, Cincinnati & Chicago Railroad.

THE Pittsburgh Locomotive Works recently completed an order for the St. Louis, Vandalia & Terre Haute Road.

THE Rhode Island Locomotive Works, in Providence, are building 12 engines for the Kings County Elevated Railroad in Brooklyn.

THE Cooke Locomotive Works, in Paterson, have recently delivered rotary steam shovels to the New York Central and the Denver & Rio Grande Road.

THE Baltimore & Ohio Company has contracted to purchase 71 new locomotives from the Finance Company, of Pennsylvania, under a trust arrangement.

Marine Engineering.

THE Cleveland Ship Building Company, Cleveland, O., is now full of work, and its yards and shops are very busy. This company is successor to the Cuyahoga Steam Furnace Company, which was established in 1832, and is therefore a contemporary of the JOURNAL.

THE Atlas Iron Works, San Francisco, recently completed a steam launch 36 ft. long, 9 ft. beam, and 5 ft. deep for the Kodiak Packing Company, for service in Alaska. The engines are compound, with cylinders 6 in. and 10½ in. in diameter and 8-in. stroke. The peculiarity about this launch is that instead of the usual condenser she is supplied with, what may be called an external condenser, consisting of a brass pipe projecting from the port side of the boat amidships, which, extending along the side, is connected with a series of 32 small tubes, each 3 ft. in length, arranged vertically under the counter, somewhat in the form of a gridiron. The inventor, J. D. Jardine, claims great economy in weight for this arrangement.

Manufacturing Notes.

THE Johnson Railroad Signal Company of Rahway, N. J., has opened an office in the Rock Island Building in Chicago. The Company will keep, on exhibition in this office, a full-size Johnson interlocking machine, with other signaling appliances.

THE Creditors' Committee of the Reading Iron Works, Reading, Pa., which recently failed, have submitted a plan for reorganization. The Committee states that this plan is apparently the only one which will avoid the very serious loss which must be caused by disposing of the Works, under forced sale. The plan provides that all claims less than $1,000 be settled by the payment of 60 per cent. on their face in cash. This will reduce the floating debt to $1,300,000. This sum it is proposed to adjust by issuing to the creditors 40 per cent. in 6 per cent. second-mortgage bonds, and the remaining 60 per cent. in third-mortgage bonds to be entitled to 6 per cent. interest if earned; all net earnings after payment of interest to be paid into a sinking fund and the voting power of the present stock to be vested in the trustees of the mortgage, so that the creditors will have full control of the management.

RIEHLE BROTHERS, in Philadelphia, report recent sales of one 20,000-lbs. horizontal testing-machine to the Bridgeport Brass Company; one 20,000-lbs. vertical testing-machine to the United States Naval Academy, and a number of smaller testing-machines to different parties; also a large number of furnace-scales, track-scales, and presses. The firm has recently filled large orders for platform-scales to go to South America.

THE Westinghouse Air-Brake Company has placed an order with Manning, Maxwell & Moore, of New York, for 214 lathes for their new shop now under construction. This is probably the largest order for machine tools ever placed at one time.

J. M. FOSTER, of New York, is supplying his steam-pressure regulator for a number of locomotives now being constructed at the Baldwin Locomotive Works. The Pennsylvania Company has also ordered a number of these regulators to be sent to its Fort Wayne and Alleghany shops, for use on its locomotives. The Philadelphia, Wilmington and Baltimore is also applying these regulators on its locomotives. Mr. Foster recently furnished one of his 10-in. pressure regulators to the Cincinnati Water Works, and now has an order for one of the same size for Asheville, N. C.

THE Phœnix Machine Company, of Cleveland, is building 18 cranes for the Anniston Pipe Company, at Anniston, Ala.; three large cranes for a Milwaukee company; one for Charleston, S. C.; a large crane for a Chattanooga and one for a Pittsburgh firm.

OBITUARY.

CAPTAIN JOHN ERICSSON died at his home in New York, March 8, aged 85 years, after an illness of about two weeks. A notice of his life and services will be found on another page.

WILLIAM S. BARBOUR, who died in Cambridgeport, Mass., February 24, aged 54 years, had been for 30 years past a civil engineer in Boston and the vicinity. For 14 years past he had been City Engineer of Cambridge, and under his charge several important works had been completed, including the system of sewerage for the city, the Stony Brook improvement and the Harvard Street bridge.

THOMAS G. MERRITT, who died in New Orleans, February 24, was well known as an engineer. He was for some 10 years past Superintendent of Bridges and Buildings on the Cincinnati, New Orleans & Texas Pacific Railroad and its controlled lines. The long bridge of the New Orleans & Northeastern Railroad over Lake Pontchartrain—the longest pile bridge in the world—was built under his direction. Few engineers, probably, had wider experience and more thorough knowledge of wooden bridges and trestles than Mr. Merritt.

CHARLES J. BRYDGES, who died suddenly in Winnipeg, Man., February 18, aged 62 years, was born in England, and for some years was employed on the London & Southwestern Railroad. In 1853 he went to Canada as Managing Director of the Great Western Railroad, and in 1862 was appointed Managing Director of the Grand Trunk. He continued at the head of the Grand Trunk in Canada until 1874, when he was appointed General Superintendent of Government Railroads, and for four years had charge of the Intercolonial and the Prince Edward Island Railroads. In 1878 he retired, was shortly chosen Land Commissioner of the Hudson Bay Company, which office he held until his death.

GENERAL DAVID P. DEWITT, who was born in Hoboken, N. J., July 10, 1817, died in Middletown, N. Y., February 26, 1889, aged 72 years. In 1832 Mr. DeWitt entered the West Point Military Academy; he graduated, and was commissioned as Second Lieutenant, Second Artillery, United States Army in 1836. He afterward resigned and entered the employ of the New York, Lake Erie & Western Railroad. After a long service with this company he was engaged in civil engineering in Canada, and afterward in railroad contract work in Ohio, Pennsylvania, and Kentucky. In 1861 he re-entered the United States Army and served during the War, retiring with the rank of Brigadier-General. After his retirement he entered the service of the United States Express Company, but gave up active business several years ago.

PERSONALS.

MILLARD F. WRIGHT has been elected Superintendent of Water Works at Lowell, Mass.

A. C. MCGRATH has been appointed Superintendent of Water Works at Chambersburg, Pa.

G. H. MCCORD has been appointed Secretary and Treasurer of the Indianapolis Car Works.

WILLIAM H. LANGLEY has been appointed Commissioner of Public Works of the city of Detroit.

COLONEL J. H. AVERILL has resigned his position as Superintendent of the South Carolina Railroad.

F. J. KROM is appointed Assistant General Car Agent of the Lehigh Valley Railroad, with office at Sayre, Pa.

M. C. KIMBERLEY has been appointed Assistant General Superintendent of the Northern Pacific Railroad.

J. F. CLARKE, Division Engineer of the Lake Shore & Michigan Southern Railroad at Toledo, has resigned, and will engage in business in Georgia.

PROFESSOR W. S. CHAPLIN, of the Lawrence Scientific School, at Cambridge, Mass., has been obliged to retire from active work temporarily on account of ill health.

H. H. FILLEY, who has been in Mexico for some time past, has returned to Kansas City. Mr. Filley still remains Consulting Engineer for the Mexican National Construction Company.

L. FINLAY has resigned his position as General Master Mechanic of the St. Louis, Arkansas & Texas Railroad. His present address is No. 902 West Fourth Street, Little Rock, Ark.

COLONEL ALDACE F. WALKER resigns his position as a member of the Interstate Commerce Commission to become Chairman of the new Interstate Railroad Association, a position for which he is well fitted.

SAMUEL SPENCER, late President of the Baltimore & Ohio Railroad Company, has accepted a position with the banking house of Drexel, Morgan & Company. It is understood that he will have charge of the very extensive railroad interests of that firm.

LIEUTENANT COLONEL ADELBERT R. BUFFINGTON has been promoted to be Colonel in the Ordnance Corps of the Army, in place of Crispin, deceased. MAJOR JOSEPH P. FARLEY is promoted to be Lieutenant-Colonel in the same corps, and CAPTAIN OTHO E. MICHAELIS to be Major.

JAMES T. HARAHAN, who left the Louisville & Nashville a few months ago to become Assistant General Manager of the Lake Shore & Michigan Southern, has now left the last-named road to accept the position of General Manager of the Chesapeake & Ohio Railroad, with office in Cincinnati.

COLONEL W. P. CRAIGHILL, U. S. Engineers, has started for Europe under orders from the War Department to investigate the latest improvements in canal locks and hydraulic lifts, for canal purposes. He is accompanied by COLONEL GEORGE H. MENDELL and MAJOR JAMES C. POST, U. S. Engineers. These officers are charged with the duty of designing a lock to overcome the obstructions in the Columbia at the Dalles, Oregon.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting in New York, March 6, the deaths of W. S. Barbour, Edward Baumann, and E. S. Philbrick, members, were announced.

The Secretary read a paper by James H. Cunningham on English Railroad Tracks, discussing Mr. Tratman's paper on the same subject. This was followed by a verbal discussion in which Messrs. Sloan, T. C. Clarke, Croes, Wegmann, Devin, Buck, and Tratman took part.

The Tellers announced the following elections:

Members: Walter L. Cowles, Cleveland, O.; Paul Didier, Pittsburgh, Pa.; Herbert S. Holt, Sherbrooke, P. Q.; William C. Kernot, Melbourne, Australia; Henry K. Owens, Seattle, Wash.; Andrew McC. Parker, New York; Albert H. Porter, Walter P. Rice, Cleveland, O.

Juniors: Stewart Johnston, Pittsburgh, Pa.; Augustus S. Kibbe, Albany, N. Y.; Walter F. Whittemore, Hoboken, N. J.

American Institute of Mining Engineers.—The fifty-third meeting was held in New York City, beginning February 19. The address of welcome was made by Andrew Carnegie, in the absence of Mayor Grant. The annual address was made by the President, Professor William B. Potter, of St. Louis, Mo.

The annual report of the Secretary showed the present total membership to be 1,830.

During the Convention the following papers were read and discussed by members present:

End-lines and Side-lines, by Dr. R. W. Raymond, New York City; Electric Storage Batteries, by P. G. Salom, of the Julien Storage Battery Company; Magnetic Separation of Iron Ores, by John Birkinbine and Thomas A. Edison; Electric Power Plant in the Comstock Mines, by N. W. Perry; Steel Rails, by F. A. Delano; Rail Sections, by R. W. Hunt; the Determina-

tion of Silicon in Ferro-Silicons; the Elliott Locked Rope, by E. G. Spilsbury, Trenton, N. J.; The Genesis of a Nail, by Oberlin Smith, Bridgeton, N. J.; Results of the Storage of Water in Arizona, by W. P. Blake, New Haven, Conn.; the Re-opening of the Tilly Foster Iron Mine, by F. H. McDowell, New York City; the Comparative Economy of Air-Compressors, by J. E. Denton, Hoboken, N. J.

The following officers were elected: President, Richard Pearce, Argo, Col.; Vice-Presidents, Eckley B. Coxe, Drifton, Pa., Charles Macdonald, New York City, and Percival Roberts, Jr., Philadelphia; Managers, J. H. Bramwell, Roanoke, Va., Frank Firmstone, Easton, Pa., and W. H. Pettee, Ann Arbor, Mich.; Treasurer, Theodore D. Rand, Philadelphia; Secretary, Rossiter W. Raymond, New York City.

The Wednesday evening meeting was a joint one with the American Society of Civil Engineers, and was devoted to papers on Steel.

On Friday evening a reception was given to the members of the Institute and their ladies by Mr. and Mrs. A. S. Hewitt.

The Convention, which was one of unusual interest, closed on Saturday, February 23, with an excursion by steamer to the Central Forging Company's Works at Whitestone Landing, the United States Engineer School and Torpedo Station at Willett's Point, and to Fort Hamilton. The process of heating and hammering heavy forgings was witnessed at the Central Company's Works; at Willett's Point the laboratories and museum were inspected, and at Fort Hamilton the dynamite gun was explained by Captain Zalinski.

National Electric Light Association.—The Annual Convention was held at Chicago, beginning February 19.

The Secretary's report showed a total membership of 175.

The following papers were read and discussed: Liquid Fuel, by M. J. Francisco; Petroleum Fuel, by S. S. Leonard; Conduits, Their Material in Relation to Underground Conductors, by A. C. Chenoweth; Disruptive Discharges in Lead Cables, by C. H. Rudd; Municipal Lighting, by F. H. Whipple; Public Ownership of Commercial Monopolies, by A. R. Foote, and Electric Light Stations as Fire Risks, by S. E. Barton.

Other interesting papers were read and discussed by the members.

The following officers were elected for the ensuing year: President, E. R. Weeks, Kansas City, Mo.; Vice-Presidents, A. J. DeCamp, Philadelphia, Pa., and E. A. Maher, Albany, N. Y.; Executive Committee, B. Rhodes, Niagara Falls, B. E. Sunny, Chicago, Ill., C. R. Huntley, Buffalo, N. Y., Dr. O. A. Moses, New York City, J. F. Morrison, Baltimore Md., and T. Carpenter Smith, Philadelphia, Pa.

The Convention, which lasted three days, was largely attended and one of much interest.

New England Water-Works Association.—The regular quarterly meeting was held in Boston, March 13. President Nevons announced the death of William S. Barbour, City Engineer of Cambridge, Mass.

An address upon the Relations of Great Ponds to the Water Supplies of our Cities and Towns was delivered by Mayor Jackson, of Fall River, Mass.

Edwin Darling read a short description of a filter-bed, which had been built in connection with the new pumping station at Pawtucket.

J. A. Tilsen described the method used in repairing a break in a 10-in. wrought-iron pipe located in the bed of the river at Cleveland, O.

Solon M. Allis, Superintendent of the Malden Water Works, asked information as to the life of cast-iron pipe, and was answered by Superintendent Darling.

The Secretary read a Description of the Repair of a Break in a Large Wrought-iron Cement-lined Main at New London, by W. H. Richards, and a paper on a Novel Way of Placing a Bridge in Position, by Charles A. Allen, Worcester, Mass.

Conference of Railroad Commissioners.—The Conference Meeting, called by the Interstate Commerce Commission, was held in Washington, March 5, 6, and 7. There were present all the members of the Interstate Commission and representatives from the State Commission of Alabama, California, Connecticut, Florida, Georgia, Iowa, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New York, Ohio, Pennsylvania, South Carolina, Vermont, Virginia, and Wisconsin. There were also present, by invitation, a delegation of the Railroad Accounting Officers, headed by President Marshall M. Kirkman.

The order of business adopted was: Uniform Statistics and Classification of Freight; Railroad Construction; Car Heating and Lighting; Automatic Brakes and Couplers, and Taxation. In relation to all, except the first-named subject, the meeting took no action, its work being confined to general discussion and conference as to the possibility of securing some uniformity in State Legislation. The importance of such action was generally admitted, and the Conference has undoubtedly resulted in a good understanding and in preparing the way for concerted action hereafter.

In relation to Uniformity of Statistics, the subject was brought before the Conference in an elaborate paper by H. C. Adams, Statistician of the Interstate Commission. The subject was referred to a committee consisting of Mr. Adams, Mr. Kirkman, and five State Commissioners. This committee reported a form for railroad reports, which was based upon that prepared by the Interstate Commission, with some modifications. This form was approved by the Conference, and it is decided to take such action as may be necessary to secure its adoption in all the States. It was also resolved to make the report year end with June 30. It was resolved to hold Conferences annually, and a committee of three was appointed to fix the time and to call the next meeting.

New England Railroad Club.—The March meeting of this Association, on March 13, was devoted to the annual dinner, which was largely attended by members and invited guests, and was thoroughly enjoyed by those present.

New York Railroad Club.—At the regular meeting, March 21, the subject for discussion was the Use of Iron in Freight Car Construction. A paper was read by Mr. G. W. Ettenger on the Tubular Form of Iron Freight Car Framing, and the subject was discussed at considerable length by those present.

Northwest Railroad Club.—At the regular meeting in St. Paul, March 5, the subject for discussion was the Best Method of Heating Passenger Cars in the Northwest. It was opened by a paper read by Mr. W. H. Lewis, which was followed by experiences of different heating systems given by members present.

Western Railway Club.—At the regular meeting in Chicago, March 19, the first subject for discussion was Axles for 60,000 lbs. Cars, continued from the previous meeting.

This was followed by a discussion on Draw-bar Rigging, which was introduced by a paper read by Mr. C. A. Schroyer, of the Chicago & Northwestern Railroad.

Baltimore & Ohio Employes' Relief Association.—The report of this Association, for the year ending September 30, 1888, shows that at the close of the year there were 20,267 members upon the books. The total receipts for the year were $359,278, and the expenditures were $358,983, of which the sum of $301,992 was for payment of benefits and $56,991 for physicians' bills, hospital accounts, and current expenses. The number of benefits paid during the year was 13,254, of which 78 were for deaths from accidents; 139 for deaths from natural causes; 3,746 for injuries from accidents; 6,629 for disabilities from sickness; while in 2,662 cases only the payment of physicians' bills was required. The total amount paid out by the Association in benefits from its organization, May 1, 1880, up to September 30, 1888, was $1,828,265, paid to 80,814 persons.

The report of the pension feature shows that there were on the list at the close of the year 154 pensioners, and the amount paid during the year was $23,438. This pension feature is sustained entirely by the Company.

The savings fund and building feature shows that the total amount of deposits is $446,991, the number of depositors being 1,283. The outstanding loans, to 706 borrowers, amount to $332,384 and the investments of the funds to $51,500. The loans are made for the purpose of purchasing and building, improving houses, and removing liens on property.

Engineers' Club of Philadelphia.—A regular meeting was held in Philadelphia, February 16. No papers or notes were ready for presentation, and after disposing of the order of business the meeting adjourned.

AT the regular meeting, March 2, the Secretary presented a communication from Mr. John C. Trautwine, Jr., now in England, covering interesting descriptions of his journey thither, of the *City of New York*, in which he sailed, the Grand Junction Water Works, and the new Tower Bridge, London, with illustrations.

Some remarks on points of English, as compared with American engineering were made by Messrs. T. Carpenter Smith and Frederic Graff.

The Secretary presented, for Mr. Samuel Tobias Wagner, a set of Conventional Signs for Bridge Rivets which Mr. Wagner refers to as being generally adopted as a standard, and having special merits.

There was some discussion by Mr. Henry B. Seaman, wherein he pointed out what he considered some of the defects of this particular system.

Engineers' Society of Western Pennsylvania.—The regular monthly meeting was held in Pittsburgh, February 19. A paper was read on International Standards for the Analysis of Iron and Steel by Professor John W. Langley. Mr. H. B. Hibbard read a paper on Welding Metals by Electricity, illustrated by samples. Both papers were discussed by members present.

A special committee was appointed to consider and report upon the Best Methods of Constructing and Maintaining Public Highways, and to recommend legislation on this subject.

Engineers' Club of Cincinnati.—A regular meeting was held in Cincinnati, February 6. Mr. Edward Flad, of St. Louis, was chosen a member.

Mr. E. J. Carpenter, who is in charge of the work of dredging done by the Government on the Ohio River, entertained the Club with a description of the work performed by the two dredges engaged in this service, describing the construction of the dredge-boats, which were built under his supervision to special plans prepared by him. The boats are, with the exception of minor parts, made entirely of iron and steel. Mr. Carpenter illustrated his lecture by lantern views, which served to show more clearly the various kinds of work performed in moving logs, stones, wrecks, and bars which form in the channel and obstruct navigation.

The regular meeting of the Club was held March 6. One new member was admitted and applications received from four.

The date of the meeting was changed from the first Wednesday to the fourth Thursday in each month.

A paper on the Methods and Results of Accurate Measurements of Base Lines in General was read by Mr. Carl Schenk.

A lunch, provided by the Executive Board, was enjoyed by the members.

Western Society of Engineers.—A regular meeting was held in Chicago, February 6. Messrs. A. D. Whitton, L. L. Wheeler, and J. H. Flagg were chosen members.

The Committee on Highway Bridges submitted a report, with a copy of the bill now before the Missouri Legislature, and stated that while some changes in details were desirable, the proposed bill was the best method yet recommended for remedying existing evils. At the present time it was not considered best to attempt to secure any legislation in Illinois.

The Committee on Standard Drawing Papers reported progress. The Committee on Employment ask for instructions, and after some discussion it was decided that the Committee be discharged and that arrangements be made to receive applications for employment, and to enter the same in a book. This was followed by considerable discussion, and the matter was closed by placing Mr. Liljencrantz in charge of the subject. After some general discussion on the work of the Society the meeting closed.

Minneapolis Society of Civil Engineers.—At the regular meeting held in Minneapolis, March 6, a paper on the Permanent Improvement of Highways was read by George E. Crary, which called out a lengthy discussion, branching into the different kinds of street pavements, and their merits.

Civil Engineers' Society of St. Paul.—A regular meeting was held in St. Paul, Minn., February 4. Messrs. C. J. A. Morris, W. W. Curtis, and R. Davenport were appointed the Committee on Membership. A communication from the Engineers' Club of Kansas City, relating to transfer of membership among different engineering societies, was read and referred to a special committee.

The paper of the evening was read by Mr. R. J. Johnson on Testing of Water Mains, by the Use of Pressure Gauges.

A regular meeting was held in St. Paul, March 4. The special Committee upon Interchange of Membership reported in favor of a plan for the same, provided all the societies would join. The Committee was continued with instructions to correspond with other societies on the subject.

The Committee on Bridge Legislation presented a report, accompanied by a copy of the act presented to the Missouri Legislature, upon this subject. This report was discussed at length by Messrs. Horton, Loweth, Osborne, Rockwell, Munster, and Mason. The general feeling, as expressed by the speakers, was rather against legislative enactments, but in favor of compelling plans and strain-sheets to be filed in some place accessible to the public; also that parties building bridges should be held strictly responsible for their safety, and liable for damages resulting from the failure.

The Secretary was instructed to have a list of the members printed and distributed.

Engineers' Club of St. Louis.—A regular meeting was held in St. Louis, February 20. Messrs. Whitfield Farnham, E. L. Goltstein, Frank S. Ingoldsby, and R. H. Phillips were elected members.

The special Committee on a Closer Union of Engineering Societies reported progress and ask for further time, which was granted. The Executive Committee submitted a special report on Transfer of Membership, which was laid over for further consideration. The Committee on Highway Bridges reported that a bill had been submitted to the Legislature. Professor Johnson then read a paper on Cast Iron; Strength, Resilience, Tests, and Specifications. The paper was very interesting, and was illustrated by drawings and formulæ. The author had devoted a great deal of time and study to the investigation of this question, and had made numerous experiments in the Washington University Testing Laboratory. He showed that the tensile strength varied from 17,000 to 36,000 lbs. per square inch, and that from 20,000 to 25,000 lbs. tensile strength should be required. He showed that experience did not bear out the commonly accepted theory, that the outside portion of a casting was stronger than the inside. In the author's opinion, the resilience or the ability of the casting to withstand shocks was by far its most important characteristic. He showed that repeated shocks resulted in a loss of resilience and that the Heisler testing machine, which is in use in the East, was open to objection on this score. Messrs. Russell, Bouton, and Wheeler took part in the discussion.

The Secretary then read a brief discussion by William B. Knight of Professor Johnson's paper on cable yokes. The author gave some data from Kansas City cable roads, showing that the strength of the yokes did not affect the slot closure. In some places it had been found necessary to break the yoke in two at the bottom, which had caused no bad results. He even thought that a good road could be built without yokes.

A regular meeting was held March 6. E. L. Goldstein, F. B. Ingoldsby, and R. H. Phillips were accepted as members of the Association.

A paper on Improving the Channel of the Mississippi, by Mr. Winslow Allderdice, was read by Professor Johnson.

Mr. Richard S. Elliott explained his plan for deepening the Mississippi channel by means of water jets under high pressure. Professor Johnson called attention to the success of some experiments made by the United States engineers at Horsetail Bar, with crude apparatus of a similar nature.

Engineer's Club of Kansas City.—A regular meeting was held March 4.

The Committee on Transfer of Members reported that copies of the constitution of the various Societies had been received and were being looked over before the proposal of any scheme.

A paper on Strengthening Railroad Bridges was read by Mr. C. E. Taylor. This paper was discussed by Mr. Goldmark.

Mr. Breithaupt reported progress on the question of Bridge Reform.

Boston Society of Civil Engineers.—At the annual meeting, March 20, the election of officers for the ensuing year resulted as follows: President, Desmond Fitzgerald; Vice-President, John R. Freeman; Secretary, S. Everett Tinkham; Treasurer, Henry Manley; Librarian, Frank W. Hodgdon, and Member of Board of Managers, Winfield S. Chapin. President Fitzgerald delivered his annual address.

Master Mechanics' Association.—The following circular has been issued by Secretary Angus Sinclair from his office, No. 140 Nassau Street, New York:

"The Executive Committee have made arrangements to hold the next Annual Convention at Niagara Falls, beginning Tues-

day, June 18, with headquarters at the International Hotel. The terms of $3 per day have been secured for members and others.

"The proprietor of the hotel mentioned has agreed to reserve 100 rooms for the use of members. All who wish to secure rooms should apply to Mr. A. H. Gluck, Manager, International Hotel, Niagara Falls, N. Y."

Master Car-Builders' Association.—The following circular has been issued from the Secretary's office:

"The Master Car-Builders' Committee appointed at the Annual Convention, held at Alexandria Bay, June, 1888, to submit an axle for 60,000 lb. cars, request the following information:

"1. How many cars of 50,000 lb. capacity have you in service?

"2. How many of 60,000 lb. capacity?

"3. Give the dimensions of the axles used under the above cars.

"4. In case you contemplate any change in the above axles, give the dimensions you propose changing to, in red ink.

"5. Should you have no cars in service of greater capacity than 40,000 lbs., give the dimensions you recommend for 50,000 lb. and 60,000 lb., in red ink.

"6. Replies to these questions should be filled in on the back of this sheet, and forwarded to the Chairman of the Committee at Aurora, Ill., if possible by March 15, 1889.

G. W. RHODES, *Chairman*,
JOHN S. LENTZ,
R. MCKENNA,
Committee.

The Committee on Standard Brake Gear for Air-Brake Cars and Brake-Shoe for Iron Beams (consisting of Messrs. E. B. Wall, G. W. Rhodes, and George Hackney) proposes to make tests of the different forms of the iron beams on the market.

Manufacturers of beams have been requested to forward beams for test, but the Committee understands that there is much private investigation under way, into the subject of iron beams, by various railroad companies and individuals connected with railroad companies.

The Committee is anxious to make its report to the Association as complete as possible, and would be glad to communicate with any persons having beams which they would like to submit for examination and report to the Association.

The Committee has stipulated to the advertised manufactures that the beams sent for test shall not show a deflection of more than $\frac{1}{16}$ in. under a load of 15,000 lbs.

All parties desiring to communicate with the Committee on the subject of brake-beams will please address their communications to Edward B. Wall, Superintendent Motive Power, Pennsylvania Lines West of Pittsburgh, Southwest System, Columbus, O.

The Committee on Car Heating has issued a circular requesting answers to the following questions:

1. Name of system in use or trial; 2. Number of locomotives equipped; 3. Number of cars equipped; 4. Number of cars in train to which heat can be transmitted; 5. What is the heating medium; 6. What pressure is carried in main pipes; 7. What pressure is carried in heating pipes; 8. How is the temperature regulated and does it require constant attention; 9. What provision is made for retaining a comfortable temperature when train is not connected to locomotive; 10. If traps are used, what kind and where located; 11. What kind of flexible connection is used between cars; 12. What couplers are used; 13. What has been the general results with couplers and connections; 14. What has been the general results with this system of heating.

Replies are to be addressed to the Chairman, F. L. Sheppard, at Altoona, Pa., as soon as possible.

NOTES AND NEWS.

The Latest Rapid Transit Scheme.—The accompanying illustrations show the latest plan for rapid transit, devised by a Western inventor, who proposes that we shall all individually be independent of monopolies and able to make our way back and forth in the quickest time and by the most direct route. Space will not permit us to enter fully into the details of this invention, which are very fully set forth in the patent specifications, but the engravings will show sufficiently well its general character. Fig. 1 shows the passenger in transit, and the artist has well depicted the graceful ease with which a journey may be effected and the elegant appearance which he—or she—will present upon the road. Fig. 2 shows the passenger just ready for flight with his broad pinions spread, and attention may be called to the magnificent and stately appearance presented by these pinions and by the—well, steering apparatus, to speak politely. The Patentee does not claim, but we might suggest,

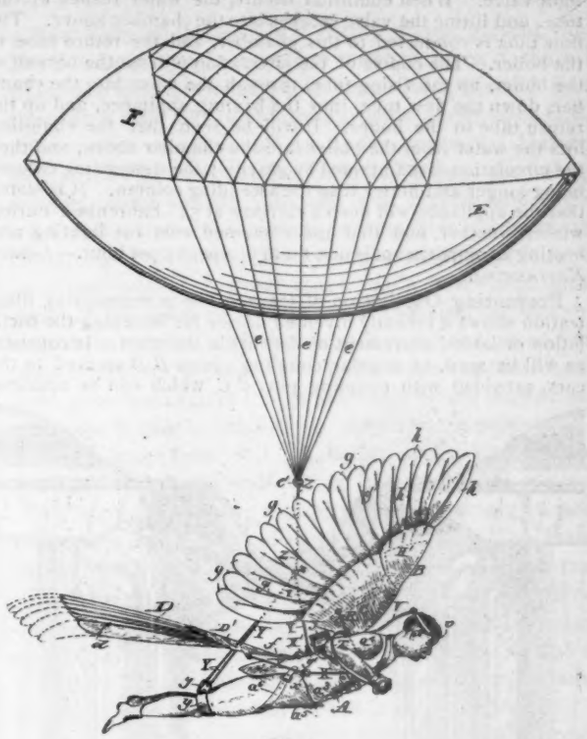


Fig. 1.

were we sufficiently familiar with such matters, that the aforesaid steering apparatus might serve the purpose of what we believe is called a bustle, for ladies using it, when they might condescend to alight upon the earth.

The inventor explains that the balloon part is not absolutely necessary, as the wings and tail can be used without it. The wings, he says, operate with practically the same effect as the wings of an eagle—which might be a dangerous admission, were the eagle in a position to file objections in the Patent Office—and he also suggests several modifications, which might be employed, as, for instance, the use of electric power for operating the machinery.

Fig. 2.

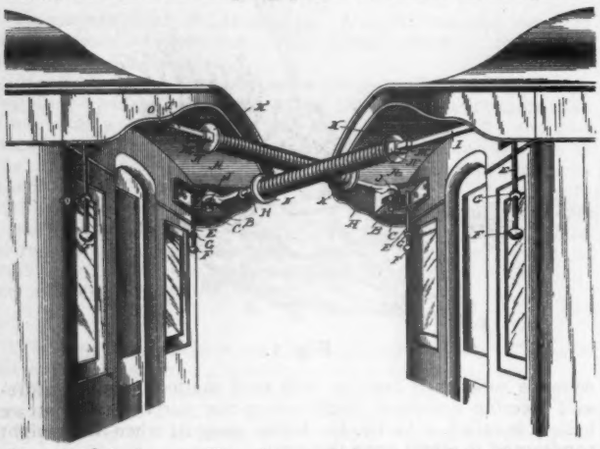
His patent contains no less than 20 claims, but in a general way it may be said that it covers a combination of a jacket or bodice with wings and tail, and the various combinations of springs and other machinery, by which they are propelled.

The Patentee of this machine is Reuben Jasper Spalding, of Rosita, Col.; his patent is dated March 5th, 1889, and numbered 398,984. A model is filed with the patent, but it is not stated whether the machine has ever been put into practical use.

The Foulis Railway Carriage Heater.—Recently there was exhibited at St. Pancras Station, in London, a railway carriage for the Glasgow & Southwestern Railway, fitted with the Foulis heater. We may briefly explain that the gas flame in the carriage roof is the source of heat, and that it is rendered available for warming the passengers by means of a tiny boiler above it, and a system of hot-water pipes connected with heaters below one of the seats. The difficulty which arises from the source of heat being at the highest point of the circulating system instead of at the lowest is got over in a very in-

genious manner. From the top of the boiler there rises a tube, which opens into a small chamber, its mouth being closed by a light valve. When ebullition occurs, the water rushes up this tube, and lifting the valve escapes into the chamber above. The flow tube is connected to this chamber, and the return tube to the boiler. The course of the circulation is from the bottom of the boiler, up the rising tube, through the valve into the chamber, down the flow tube, into the heating appliance, and up the return tube to the boiler. It will be seen that the ebullition lifts the water from the boiler into the chamber above, and then the circulation is maintained by gravity ; the descending column being longer and hotter than the ascending column. It is stated that the appliance will keep a carriage at 54° Fahrenheit during winter weather, and that the combined cost for lighting and heating a compartment is one-tenth of a penny per hour.—*London Engineering.*

Preventing Oscillation of Cars.—The accompanying illustration shows a recently invented device for lessening the oscillation or lateral movement of the cars in the train. It consists, as will be seen, of angular coupling plates *B B* secured to the cars, provided with coupling pins *C C*, which can be operated



from the platform. The form of these coupling plates is no material to the patent.

Between each pair of couplings, but extending obliquely across the ends of the car, so that one end connects with one of the cars at one side and the other end at the opposite side of the adjacent car, is a connection consisting of the rods *H I*, arranged in pairs, each provided at their outer ends with eyes *J*, through which the coupling-pins pass. Sleeved upon these rods, and holding the inner ends of each pair thereof parallel and close together, are disc-like plates *K*, between which, and also sleeved upon the rods, are confined strong coil-springs *L*, the said disc in turn being confined between lugs *M N*, rigidly secured to the rods *H* and *I*, respectively, one near the extreme end of the rods and one toward the opposite end, both beyond the discs, the whole forming a sliding or telescope connection between each pair of rods, which are guided and prevented from separating solely by the disc-like plates *K*. The lugs on the rods are so located that the springs at all times are under a slight tension, and are so arranged that no matter which direction the rods are moved relative to each other the spring will be compressed, one lug on each rod operating at a time and in one direction, while the other pair of lugs operates when the rods are moved in the opposite direction, both, however, as aforesaid, operating to compress the spring.

Thus it will be seen that with the two sets of rods and springs or the double yielding connection shown in the drawings extending obliquely between the adjacent cars, whenever either car lurches to one side or the other, both connections will operate, although the rods in one connection are extended, while in the other they are telescoped ; and it is therefore obvious that either one of these connections might be dispensed with and the same result be accomplished ; but in that case it would be found advantageous to make the springs stronger than if a pair of such connections were employed.

This device is the subject of a patent, No. 397,902, issued recently to William E. Elliott, of Chicago.

Engineering Schools in Japan.—In his address at the third Commencement—as we should call it in this country—of the Imperial University of Japan, the President, Mr. H. Watanabe, presented a concise outline of matters related to that institution which will interest all who note the progress of the higher education in the far East. After referring to the departments of Literature, Law, Science, and Medicine, he said that perhaps the outlook of the Engineering College is the most satisfying. The construction of new engineering works and appliances throughout Japan is increasing to such an extent that the graduates of this College are insufficient to meet the demands for properly qualified professional men. Courses in sanitary engineering and the technology of arms and explosives have recently been added to curricula already very full. New buildings on the University grounds just completed for the Engineering College are now ready for occupancy. Of the 35 graduates of this College, 13 are in civil engineering, two each in mechanical engineering, naval architecture and electric engineering, one in architecture, 11 in applied chemistry, and four in mining and metallurgy.

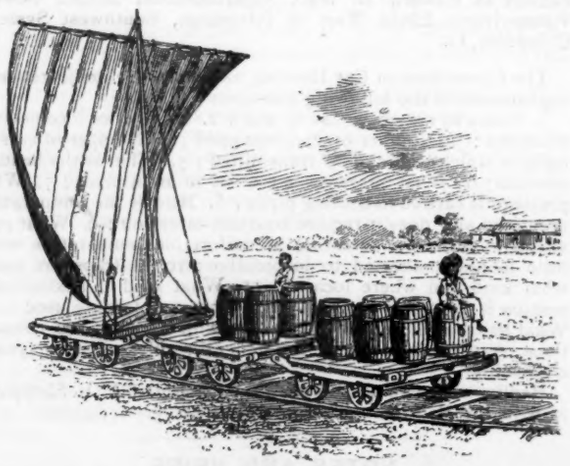
In furthering astronomical ends, the Japanese officials have made a wise move in the consolidation of the three Government observatories at Tokio into one. This is known as the Imperial Tokio Observatory, and is attached to the Mombusho, or Department of Education, with Professor Terao as director. It is thus under the control of the University, and its site is that heretofore known as the Imperial Naval Observatory, in Azabu, whither the instruments and apparatus of the two other former observatories are removed. The principal telescopes are of the best German and English construction.

The total number of students of the University, including elective and special students, is now about 800, and more than 200 scholarships, for the most part on the loan system, are available.

Trade Schools.—The Pratt Institute in Brooklyn, which began its work in 1887, with 12 pupils, is now well established, and has carefully arranged courses, including general technical instruction, and also special courses in the building and other trades, including carpentry, foundry-work, smith-work, machine-work, plumbing, masonry, etc. The Institute is supplied with a number of machine tools, wood-working tools, and other appliances for practical instruction.

The New York Trade School, founded by Colonel R. T. Auchmuty, for the practical instruction of boys in the various building trades, is very successfully at work, and has a large number of students.

A Wind Locomotive.—A naval correspondent of the London *Engineering*, writing from Malden Island, in the South Pacific, says : "The guano fields which are being worked at present are at the other end of the island, and a tramway, about five miles in length, has been constructed to bring the guano down to the pier. The hauling work on the tramway is done by sail power and by hand. There are neither horses nor steam locomotives. The trucks are pushed up to windward, loaded, and then sail is made, and the tram comes along at a fine rate. The engine truck carries a single mast in its center, rigged with a large sail. The first time I saw the train the trucks were



empty. I asked the man in charge to hoist his sail while I took a photograph. He accordingly did so, but the trucks having neither way on them nor ballast in them, the engine promptly capsized. However, I was more fortunate on another occasion, as the annexed engraving shows."

Boiler Explosions.—The *Locomotive*, published by the Hartford Steam Boiler Inspection & Insurance Company, reports for the United States in 1888 a total of 246 boiler explosions, by which 331 persons were killed and 505 injured. The greatest number of explosions reported was 69 in saw-mills and other wood-working shops ; of portable and agricultural boilers there were 30, locomotives 23, and steamboats 20. The figures are not, of course, official, but are very carefully collected by the company's agents.